ANTENNA INSTALLATION MANUAL

FOREWORD

Television in Australia has advanced rapidly since transmissions first commenced in 1956 and considerable experience has thus been gained in this important and profitable business. Courses have been made available for T.V. engineers and technicians.

A comprehensive range of text books covers television transmitting theory and the design of complex transmitting antenna arrays. Many other excellent publications embrace television receiver theory and the design and servicing of T.V. receivers, all detailing the improved technology now available.

It is difficult however, to find publications which deal adequately with the very important "link", **The receiving Antenna System,** and unless this can efficiently transfer the signal from transmitter to receiver faithfully without changing or polluting it, then the high quality results which are possible cannot be realised.

The passage of time has created an awareness that many existing antenna installations have been of less than satisfactory standard and that an improvement in system design, the use of better equipment, and the adoption of better methods of installation, has become necessary and desirable. This is particularly so with the advent of U.H.F. transmissions. The minimum requirements for proper colour reception are the same as for good quality black and white pictures. To satisfy customers and obtain this standard, quality equipment use, coupled with proper installation practice is not only necessary, but essential.

The staff of Hills Industries have amassed a great deal of practical experience in antenna systems installation work in surveys, tests and in the successful solution of customer's problems in the field. This manual has been prepared by some of those staff members so that their experience can be of real benefit to others. It is based on a course of instruction originally designed to assist the users of Hills antennas and equipment upgrade their installations to higher technical and performance standards economically.

So, herein published is our second instruction manual for all who are involved in the installation of good television antenna systems and who wish to use Hills reliable products and system components.

We wish you success, with Hills as partners ever-willing to support your activities in creating and satisfying customers and building the goodwill necessary for progress.

R.D.H. LING
CHAIRMAN AND MANAGING DIRECTOR
HILLS INDUSTRIES LIMITED.

VERY BASIC / LOW TECH/
NOT EXPLICIT TO DETAIL /
OVERLY LINKED TO HILLS PRODUCTS ?
NOT STATE OF THE ART /

ANTENNA INSTALLATION
AND
TELEVISION SYSTEMS
MANUAL

COMPILED BY

R.F.W. CASTLE

AT

HILLS INDUSTRIES LIMITED

ACN 007 573 417

RCVD 23/02/93
FROM KEVIN DAWKINS

This manual has been compiled by R.F.W. Castle at Hills Industries Limited., with valuable data from the late P.J. Mangan, who was responsible for the original HILLS ANTENNA INSTALLATION MANUAL.

The illustrations and drawings have been drawn from the original publication, technical illustrations in Hills brochures and other information leaflets, while thanks must also be extended to the printing department for their efforts in retouching some of my basic efforts. Thanks must also go to the other members of the Hills team for their assistance in seeing this publication to fruition.

Printed at Edwardstown by Hills Printing Service.

INSTALLATION AND SYSTEMS MANUAL

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Section One

1.1. Introduction

Over the years, since the introduction of Television Services to our society, the technical parameters of both the visual and audible components have continued to improve steadily.

Colour transmissions have replaced monochrome. Stereo sound is available on the more expensive receivers and Teletext decoders after a faltering start are set to gain their market share.

With each step forward, the viewer expects to see this improvement reflected in the performance of his own receiver.

If this is to be achieved, it is necessary that the method used to collect and distribute the television signals should likewise have improved over the intervening years.

To this end we trust that this updated volume, will provide assistance to all persons who are involved in the provision of television reception to both domestic and commercial customers.

It is our aim to explain the theory which lies behind the choice of component parts, while passing on some practical hints which are the result of our many years involvement in the industry.

1.2 The Basic Requirements of an Antenna System

(a) To provide the best possible television picture which is available. —Free from Ghosting, Patterning and Noise.

(b) To provide as many channels as are available in a given situation.

(c) To provide for as near maintenance free operation as possible.

To provide these parameters, in however simple a system, the following requirements must be achieved.

(a) To provide an adequate signal level.

(b) To employ system components which can achieve the required performance level.

(c) To transfer the received signals to each system receiver without the introduction of any picture or sound defects.

In order that we can achieve this basic requirement we must first be aware of the fundamentals which govern the design of television system products and the way they are employed in this facet of engineering.

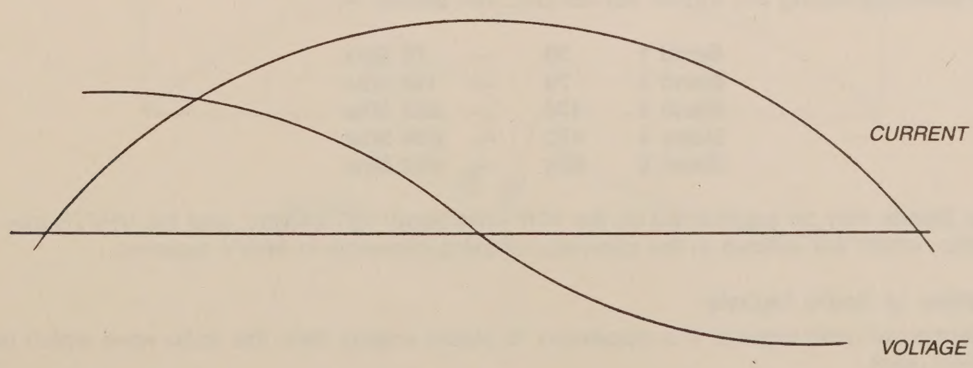
1.3 Electromagnetic Waves. Propagation.

Electrical energy that has escaped into **FREE SPACE** exists in the form of Electromagnetic waves. These waves, which are commonly called **RADIO** waves, travel with the velocity of light and consist of magnetic and electrical fields that are at right angles to each other and also, at right angles to the direction of travel.

The essential properties of a radio wave are the Frequency, Intensity, Direction of travel and Polarization.

The radio waves produced by a transmitter's alternating current will vary in intensity with the frequency of the current and will be alternately positive and negative as shown in *Fig 1.A.*

Fig 1.A



1.3.1. Wavelength.

The distance occupied by one complete cycle of such an alternating wave is equal to the velocity of the wave divided by the number of cycles that are transmitted each second and this is called the **WAVELENGTH.** Wavelength is indicated by the Greek symbol λ (Lambda). So the relationship between wavelength in Metres and frequency F in Hertz, (or cycles) per second is therefore:—

$$\frac{300{,}000{,}000}{F}$$

Note:

The velocity of light in Free Space being approximately 3 x 10 to the power 8 metres/second.

1.3.2. Frequency

The frequency of a radiated wave is determined by the rate of change which occurs at a given point in space, as the wave first rises to its positive maximum, then returns to zero and proceeds to reach its negative maximum, before again returning to zero, for each second of elapsed time.

Frequency was previously expressed in Kilocycles (Kc/s) of Megacycles (Mc/s).

However, during the 1960's, in recognition of the work performed by Mr. Hertz, which led to our present understanding of the propagation of radio waves, the term cycle was replaced with the term Hertz. So we now have Khz (1,000Hz.) and Mhz (1,000,000Hz.)

1.3.3. Polarization

The transmitted wave front may arrive in one of three polarizations. Horizontal, Vertical or Circular.

That is the wave, if we would see it, would arrive at the receiving device with either its voltage maxima being displaced from Left to Right, Up or Down, or a combination of both polarities.

For our purpose, it is normal to find the received TV signals are either Horizontally or Vertically polarized.

1.4 Propagation of Radio Waves.

As radio waves travel away from their source, the transmitter, they become attenuated or weakened.

This is due in part to the fact that the waves spread out. In addition the energy may be absorbed by the ground or by ionized regions of our atmosphere. The waves may also be reflected by obstructions in their path, either by natural or man-made objects or refracted by passing over water.

These effects on propagation are very complex and differ for differing frequency bands. For our purposes we will consider only the frequencies which are currently employed in the provision of Television services.

At this time such services are confined to the range 40 to 860Mhz. but no doubt in the future further frequency allocations will be made as the demand for more TV channels increases.

By definition the following are the presently available frequencies:—

VHF services 30-300 Mhz.

UHF services 300-3000 Mhz.

These frequency grouping are further sub-divided into Bands:—

Band 1	**30**	**—**	**70 Mhz**
Band 2	**70**	**—**	**110 Mhz**
Band 3	**174**	**—**	**230 Mhz**
Band 4	**470**	**—**	**606 Mhz**
Band 5	**606**	**—**	**862 Mhz**

The above Bands may be augmented by the VHF/mid band 118-174Mhz. and the VHF/Super Band 230-279Mhz. which are utilized in the provision of extra channels in MATV systems.

1.5 Reception of Radio Signals

In the reception of radio signals, it is necessary to obtain energy from the radio wave which passes the receiving point.

Any antenna capable of radiating electrical energy is also able to absorb energy from a passing radio wave. This occurs because the electromagnetic flux of the wave, in cutting across the receiver antenna element, induces in the antenna a voltage that changes in value in time with the radiating current of the transmitter.

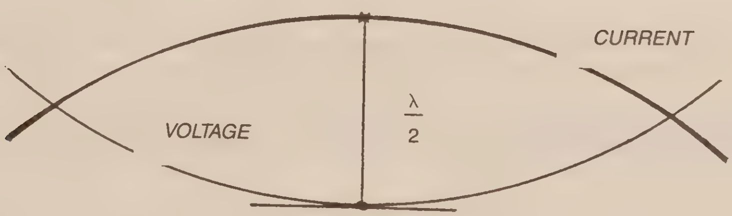
This induced voltage, in association with the current that it produces, represents energy that is absorbed from the passing wave.

Since every wave which passes the receiving antenna induces it's own voltage into the antenna element it is necessary to adjust the length of the antenna element to a length which attracts in the main, only the desired signal voltages.

1.6 The Required Characteristics of an Antenna.

If we produce a metal rod of a length equal to $\frac{\lambda}{2}$ (our required wavelength divided by two), we will absorb from the passing wavefront the voltage as represented in our diagram Fig 1.A of a single wavelength. So, the absorbed voltage for a half wavelength will be as represented in Fig 1.B below, where voltage and current are 90 degrees out of phase.

Fig 1.B



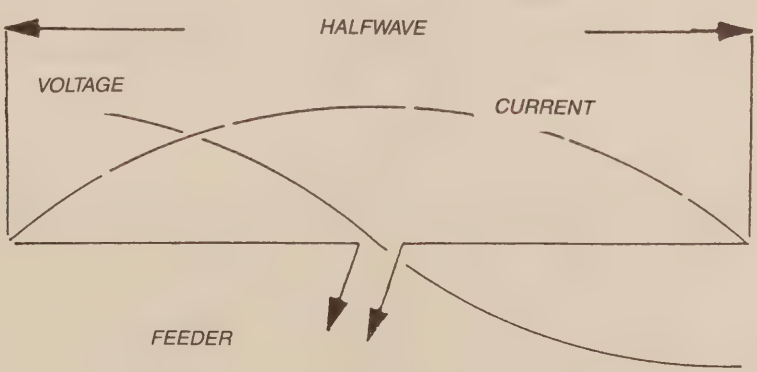
The voltage is at maximum at the opposite ends and zero in the centre, while the current is at a maximum when the voltage nears zero.

The frequency at which this arrangement occurs is called the **RESONANT** frequency and the element is said to be a Resonant Half Wave Dipole

The signals received by the dipole will be re-radiated unless we take steps to contain them.

One method is to cut the dipole at it's centre. see *Fig 1.C.* and connect a feeder to the two ends. The other end of the feeder can then be terminated by a receiver.

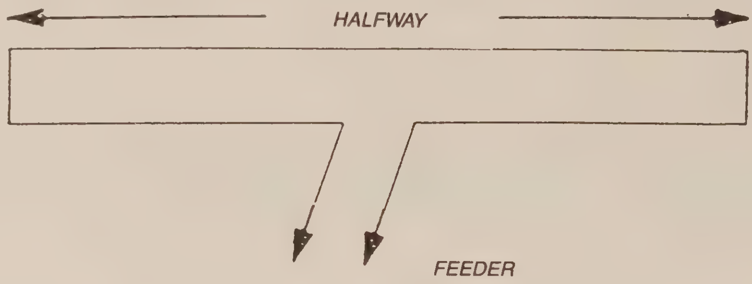
Fig 1.C



The connection point of the dipole would exhibit a characteristic impedance. This by nature is found to be approximately 70 ohms. Therefore, it can be connected directly to a 75 ohm co-axial cable. (see Hills TC series UHF Antenna).

Many antennae however, make use of a folded dipole. That is two identical half wave dipoles placed close to one another (see *Fig 1.D)* with their ends shorted, produce at their centre an impedance which is four times that of the single dipole, i.e. 300 ohms.

Fig 1.D

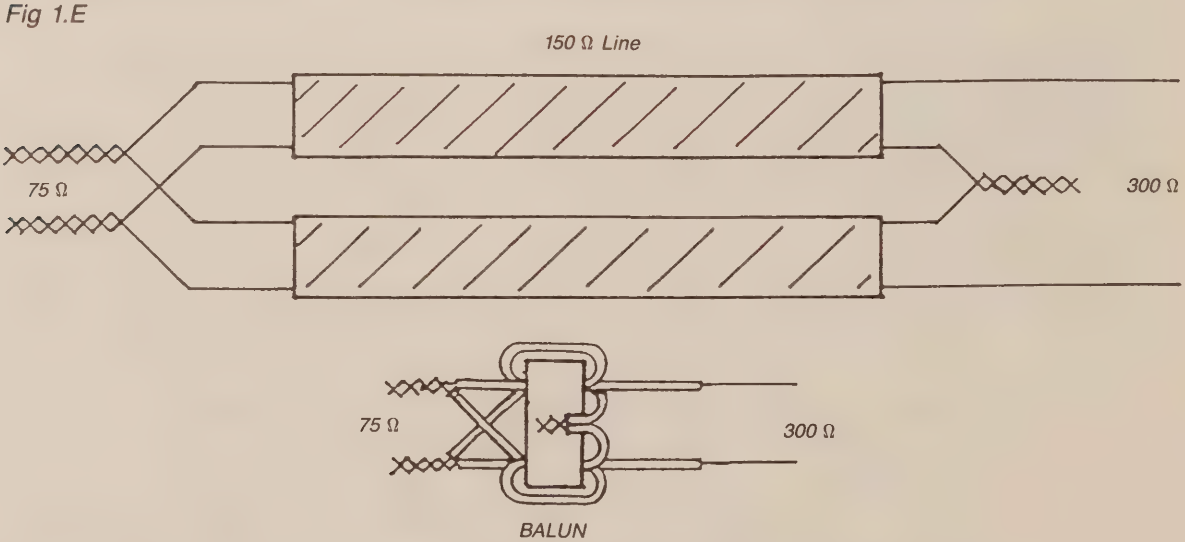


As the voltage which is developed at this point is near zero it is convenient to connect the dipole element direct to the antenna boom. As you can appreciate this is a great help in the physical design and in manufacturing technology.

In the past, when ribbon feeder was popular, such a device could be connected via 300 ohm ribbon direct to the tuner input of a TV receiver.

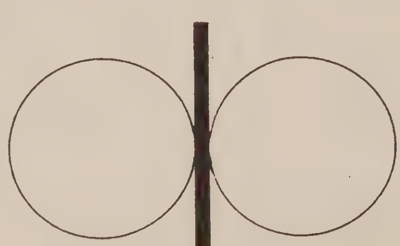
Since the wide acceptance of 75 ohm co-axial cables, it is common place to adapt this 300 ohm balanced impedance to 75 ohm unbalanced, by the use of a BALUN transformer see *Fig 1.E*

Fig 1.E



This basic antenna has unity gain and produces a directional pattern as shown in *Fig 1.F*

Fig 1.F



In most practical situations a simple dipole is insufficient to produce our basic requirement for an interference free picture.

It has insufficient gain, is only matched to one frequency and receives a signal equally well from the back as from the front. Our ideal antenna would produce adequate gain, would be well matched to the required band of frequencies and provides rejection of the signals which do not emanate from the required direction. That of the chosen transmitter.

We sum up these requirements under the following headings.

1.6.1 Gain

When an antenna in it's composite format is compared to a basic dipole at it's **RESONANT** frequency, the difference in the voltage which may be measured at the pick off points, is an indication of the increased performance. This is called the antenna **GAIN.**

For our convenience this difference is expressed in dB or decibels.

$$\text{i.e. } 20\text{Log}_{10} \times \frac{V_2}{V_1}$$

$$= 20 \times \text{Log}\,\frac{6.0}{1.0} = 15.56\ \text{dB}$$

1.6.2. Response.

The antenna should exhibit the ability to receive with equal gain all the TV signals it is designed to cover.

This statement is not in point of fact true, as in wideband antennae the gain of the antenna is optimised to the highest frequency it is required to receive. However, over any one channel this slope is very small indeed.

1.6.3. Directivity.

The antenna should be designed to accept signals over as narrow an angle as is possible and should subdue any other signals which emanate from outside this narrow beam.

1.6.4. Impedance.

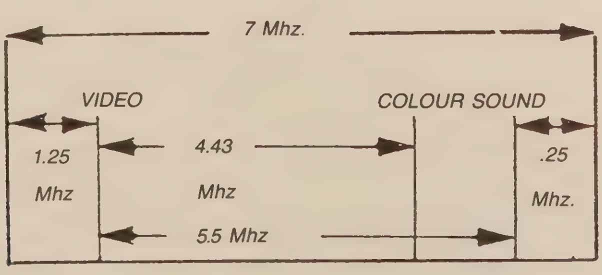
By design the antenna must match the impedance of it's feeder, so that a maximum transfer of signal energy (voltage), may be achieved. This match should be as near equal over the band of frequencies which are to be received as is possible.

1.7 Television Standards

The Television signal as we know it, is generated by two separate transmitters, one to produce the picture, the **Video** transmitter and one to produce the sound, the **Audio** transmitter. Additional to these two basic outputs the Video transmitter also provides for the **colour sub-carrier,** while the sound carrier is now produced with Left and Right channels for use when transmissions are in **stereo.**

The carrier or fundamental frequency of these two transmitters is separated by what is known as the video/audio spacing. For signals which are transmitted inside the Commonwealth of Australia the carrier arrangement is as shown in *Fig 1.G*

Fig 1.G



The video information which modulates the vision transmitter carrier utilizes 5 Mhz. of video bandwidth to produce the required **RESOLUTION** (picture quality). As the modulation changes with amplitude from a White level (minimum modulation) to a Black level (maximum modulation), the intermediate levels of modulation produce the Grey scale which makes up a received picture.

In most cases the audio transmitter frequency is placed above the frequency of the video carrier and in our case this is so. The audio carrier is Frequency modulated to a deviation of 25 Khz.

1.7.1. World Television Standards

As the total transmission spectrum which is available to us in the VHF/UHF region, is also required to service navigational aids, two-way radio, amateur radio and other commercial services, it was agreed by an International Conference to limit the frequencies which are available for Television transmission to those previously listed under TV Bands, (see page 5).

As Television developed independently in Europe and America, standards were developed on an ad hoc basis such that different manufacturers devised their own methods for transmission of TV pictures and sound.

The first National service which was provided from the Crystal Palace transmitter in London England, in 1936, used a 405 lines per frame format, with 3 Mhz. of video bandwidth and a negative audio/video separation of 3.5 Mhz., i.e. the sound transmitter had a lower frequency than the vision transmitter.

Further developments to improve the quality of the service led to an increase in the number of lines per frame transmitted. In America to 525 lines, in most of Europe to 625 lines, however, in France in a search for High Definition 819 lines were employed.

As the various countries were by now committed to their own National standards, the result of World Conferences (1963/1970) which were set up to determine operational standards only confirmed the "status quo".

See International TV Standards . . . page 13

INTERNATIONAL TV STANDARDS

Country	VHF	UHF	Colour
Algeria	B	H	PAL
Argentina	N	N	PAL
Australia	B	B	PAL
Austria	B	G	PAL
Bahrain	B	—	PAL
Belgium	B	H	PAL
Bulgaria	D	K	SECAM
China	D	K	PAL
Cyprus	B	G	PAL
Czechoslovakia	D	K	SECAM
Denmark	B	G	PAL
Egypt	B	G,H	SECAM
Finland	B	G	PAL
France	E/L	L	SECAM
Germany (West)	B	G	PAL
Germany (East)	B	G	SECAM
Gibraltar	B	H	—
Great Britain	A/I	I	PAL
Greece	B	H	SECAM
Holland	B	G	PAL
Hong Kong	(A)I	I	PAL
Hungary	D	K	SECAM
Iceland	B	G	PAL
India	B	—	PAL
Indonesia	B	—	PAL
Iran	B	G	SECAM
Iraq	B	—	SECAM
Ireland	A/I	I	PAL
Israel	B	G	PAL
Italy	B	G	PAL
Japan	M	M	NTSC
Jordan	B	G	PAL
Korea (Rep)	M	—	NTSC
Kuwait	B	G	PAL

Country	VHF	UHF	Colour
Lebanon	B	—	SECAM
Libya	B	H	SECAM
Luxembourg	C	L	PAL/SECAM
Malta	B	H	PAL
Malaysia	B	G	PAL
Mexico	M	M	NTSC
Monaco	E	L	SECAM
Morocco	B	H	SECAM
Nigeria	B	G	PAL
Norway	B	G	PAL
Pakistan	B	—	PAL
Phillipines	M	M	NTSC
Poland	D	K	SECAM
Portugal	B	G	PAL
Oman Sultanate	B	G	PAL
Qatar	B	—	PAL
Rumania	D	K	PAL
Saudi Arabia	B	G	PAL/SECAM
Singapore	B	G	PAL
Spain	B	G	PAL
Sri Lanka	B/H	—	PAL
South Africa	I	I	PAL
Sweeden	B	G	PAL
Switzerland	B	G	PAL
Syrian Arab. Rep.	B	H	SECAM
Thailand	B	—	PAL
Tunisia	B	—	SECAM
Turkey	B	G	PAL
U.A.E.	B	G	PAL
U.S.A.	M	M	NTSC
U.S.S.R.	D	K	SECAM
Yemen P.D.R.	B	—	PAL
Yugoslavia	B	G	PAL

CCIR-Standard	A	B	C	D	E	F	G	H	I	K	K1	L	M	N
Number of Lines	404	625	625	625	819	819	625	625	625	625	625	625	525	625
Channel bandwidth (MHz)	5	7	7	8	14	7	8	8	8	8	8	8	6	6
Video bandwidth (MHz)	3	5	5	6	10	5	5	5	5,5	6	6	6	4,2	4,2
Video-to-sound spacing (MHz)	−3,5	+5,5 (+5,742)	+5,5	+6,5	+11,15	+5,5	+5,5 (+5,742)	+5,5	5,5	+6	+6,5	+6,5	+4,5	+4,5
Vestigial side band (MHz)	0,75	0,75	0,75	0,75	2	0,75	0,75	1,25	1,25	0,75	1,25	1,25	0,75	0,75
Picture modulation	Pos.	Neg.	Pos.	Neg.	Pos.	Pos.	Neg.	Neg.	Neg.	Neg.	Neg.	Pos.	Neg.	Neg.
Sound modulation	AM	FM	AM	FM	AM	AM	FM	FM	FM	FM	FM	AM	FM	FM

1.8 Receiving Antenna Design

While the resonant half wave dipole remains the heart of any antenna, in situations, close to the transmitter, it is enough to produce an acceptable picture, however, in the majority of cases, such a basic device leaves much to be desired.

1.8.1. Yagi Antenna

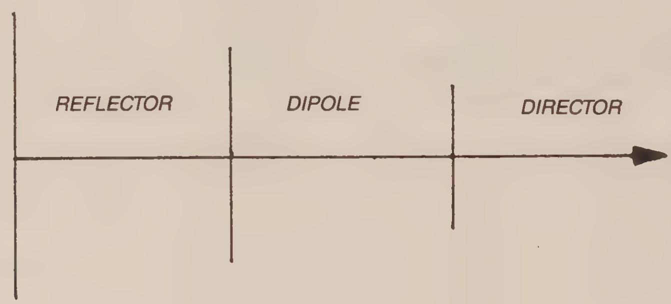
A secondary element coupled to the driven element will affect the directional pattern as a result of the currents that are induced in it.

A secondary element used in this way is called a **PARASITIC ELEMENT.**

If resonant at a slightly higher frequency i.e. cut slightly shorter than the driven element, the parasitic element acts as a **DIRECTOR** and tends to concentrate the radiated field in the driven elements direction.

If a parasitic element cut to be slightly longer than the driven element is placed close by, it exhibits a different effect and reflects back to their source any voltages which impinge upon it. If three elements are arranged together (see *Fig 1.H)* a simple, but directional antenna results.

Fig 1.H



Antennae of this type which consist of a driven element and one or more directors or reflectors which are arranged along a line, are often called **YAGI** types, after their originator.

Such basic antennae as shown above will produce a gain in the order of 6dB when adjusted for maximum radiation in the indicated direction.

In order that the **BANDWIDTH** of our Yagi may be extended to cover several channels while retaining the effective impedance of the driven element, or match, a further parasitic element, known as a **RESONATOR,** may be employed.

When placed in close proximity to the driven element, such an element can be used to modify the current distribution in the driven element, to produce resonance over a range of frequencies.

While the gain of our Yagi may in theory, reach a value of some 19dB, by the addition of directive elements, this is only practicable at UHF frequencies where the dipole size is small.

The physical constraints of such a device at VHF are too costly. Even so, at UHF frequencies, use has to be made of special techniques if this gain figure is to be achieved.

1.8.2 Colinear Yagi.

A typical use of the Resonator may be found in the Colinear Yagi design.

Here, a driven element is produced which is three half wavelengths long.

It is resonated by three half wavelength parasitic elements which are joined in line end to end, each element being insulated from its fellow, placed as a reflector behind the driven element.

Similar arrangements of three parasitic elements are provided as directors.

This has the effect of producing three "virtual" Yagis side by side.

The resultant performance is a narrower frontal lobe giving extra gain and deep nulls in the side lobe reception pattern, these act to cut down the effects of ghosting.

1.8.3. The Log Periodic.

True forms of Log Periodic antennae are used in the H.F.Band, (1.5-30Mhz) in wide banded receiving antenna arrays. This design is virtually frequency independent of its impedance matching and produces a constant radiation pattern over a wide frequency band.

Dipoles of different lengths are centre fed and are connected to each other by a system of Phasing wires.

When used for VHF television reception, such a design, as is seen in our **Telray** series, requires the use of resonators and directors to enhance the gain characteristics for channels in Band 3.

1.8.4. Forms of Practical Antenna Which are Used in the Reception of Television Signals.

The following basic groups of antenna cover the presently allocated frequency requirements:—

1. **Single Channel Yagi (VHF-UHF).**
2. **Wideband Yagi (UHF).**
3. **Combination Yagi (two or more VHF channels).**
4. **Colinear Yagi (two or more VHF channels).**
5. **Log Periodic (with colinear VHF).**
6. **Combination Log Periodic/Yagi (VHF/UHF).**
7. **Phased Array VHF/UHF.**

1.8.4.1 Single Channel VHF or UHF Yagis.

Such a Yagi is designed to cover one channel spacing only. While such a design will receive other adjacent channels, a rapid roll-off in performance is observed.

See Hills Channel 2 six element 6/2 Yagi nine element 9/4 Yagi.

1.8.4.2. Wideband Yagis.

While the single channel Yagi is designed to roll-off in performance rapidly on either side of a specific frequency spectrum, in some cases it is expedient to extend this narrow coverage.

For instance, in the UHF Band, where some required frequencies occur in Band 4, (Channel 28) and others are located in Band 5, it may be expedient to use only a single antenna.

To provide such an extended coverage, the parasitic elements are staggered in their spacing and the element lengths are varied. As this in turn causes the overall gain to be reduced, additional elements must be provided to regain the previous performance parameters.

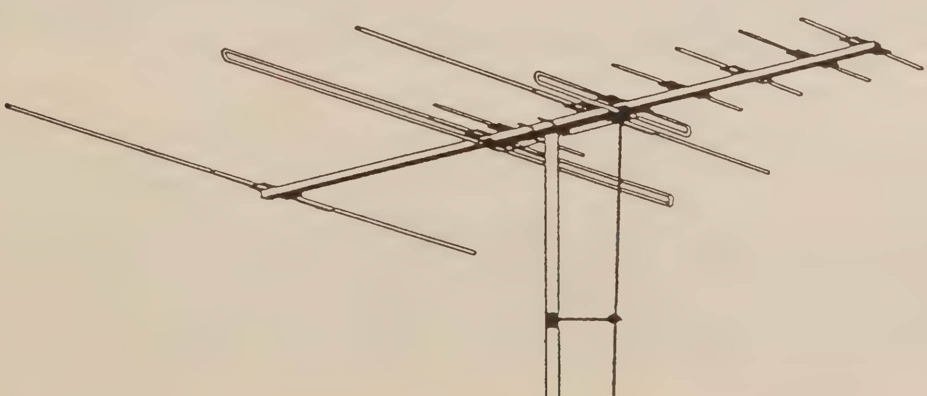
1.8.4.3. Combination VHF Yagis.

A high band Yagi can be combined with a low band Yagi and their folded dipoles connected by coupling bars which have been arranged to match the impedance of both dipoles.

In addition, the low band dipoles can be used to reinforce reception on the high band by the use of a high band resonator placed close to it.

This applies where a third harmonic relationship exists between the low and high band frequencies, such as is the case with Australian Channels 2 and 7/9, as is to be found in capital cities. A typical example is shown in *Fig.1.J* below.

Fig 1.J



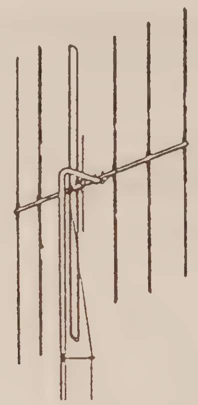
1.8.4.4. Colinear VHF Yagis

By using a colinear reflector and colinear directors, together with a three halfwave dipole with high band resonator, the result is to produce virtually three high band Yagis side by side.

The resultant high gain and good directivity, help to solve high band ghosting problems.

In this type of antenna, as shown in *Fig 1.K* a low band dipole and low band reflector provide adequate low band gain in most situations. On the high band, the colinear reflector can be seen with the resonator and low band dipole to be giving the characteristic three Yagis, side by side.

Fig 1.K

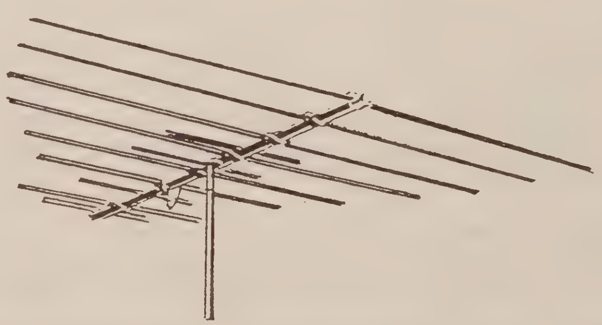


1.8.4.5. Log Periodic Antenna.

Hills Telray range of Television antennae are designed to cover the VHF band, Australian channels in Bands 1 and 3, together with FM radio frequencies (or the old Band 2).

The design incorporates a basic log periodic driven section with additional parasitic elements which are provided to increase the gain and improve directivity to Band 3, where the performance of the driven section would decline.

Fig 1.L

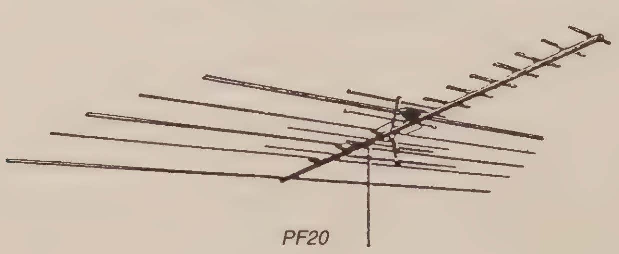


1.8.4.6 Combination Log Periodic/Yagi.

With the advent of our SBS service on Channel 28 in Band 4, co-located on the transmitter tower with the previous band 1, Channel 2 National service, in many situations, a need developed for the provision of a combined VHF/UHF antenna.

Hills answer to this situation was to combine the VHF Telray with our TC10 Band 4 antenna. The driven elements were combined in a circuit assembly and a common boom used to suport both sets of elements.

Fig 1.M



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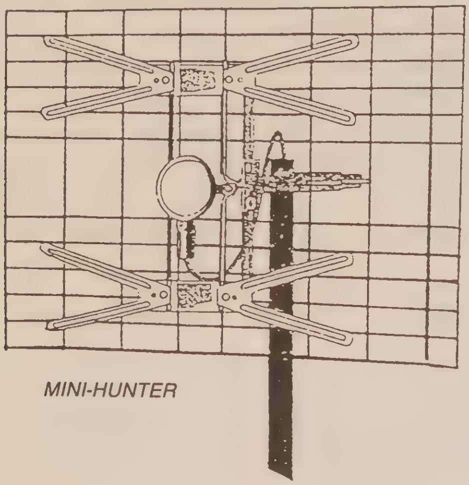
1.8.4.7. Phased Array VHF & UHF.

The Phased Array is based on two colinear halfwave dipoles arranged as a pair in phase, so that their signal voltages combine and add together in value.

A similar arrangement placed to their rear acts as a reflector. Stacked in a series of four vertically, as in the **Hills CA16,** with each pair of elements being interconnected to its neighbour by the use of a phasing harness. This results in a high degree of forward gain without the narrowing of the reception lobe as is the case for a Yagi type of comparable performance.

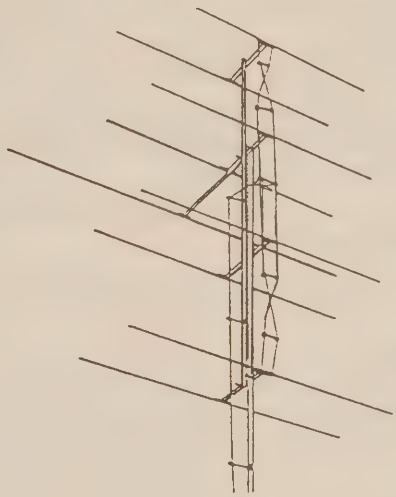
At UHF such an arrangement provides for a relatively wideband, medium gain (12dB) antenna, with very compact mechanical parameters.

Fig 1.N



MINI-HUNTER

CA16



1.9 Stacking of Antennae.

As the effective gain of an antenna is directly proportional to its size, the mechanical properties of volume, weight and wind loading, often limit the gain which is available to us.

In most metropolitan situtations the existing range produces the optimum antenna for any given location.

In the middle and far distance however, from both metropolitan and country transmitters, the signal which is gathered by even the most high gain of antenna types, is insufficient to produce the required standard of picture quality.

This is due in part to the weakening radiation which is available, but also to the profile of the Earth's curvature.

In effect we are over the horizon so far as a line of sight situation is concerned.

As radio waves in the VHF/UHF spectrum radiate in near straight lines, which do not hug the contours of the earth, as is the case with Low frequency waves, it is of great assistance in such remote locations, to utilize a mast or tower.

By placing the antenna at a sufficient height, the direct path is once again achieved.

In some ways this is in fact counter productive.

While the signal level at the antenna is increased, because the antenna is now some 50-100Ft. above the ground level, by the time the signal is passed via the required 100 plus Ft. of coaxial cable, to your lounge room, the advantage has been negated.

The practical solution is to employ a Pre-Amplifier, (mast head/booster), which, having some 20dB. of gain, overcomes the losses which are to be found in the cable, with some to spare to be used if required for additional outlets. This amplifier however, injects its own internally generated noise onto the picture.

So, if we were able to place our TV receiver at the top of the tower and view the picture, the quality would be better than that in the lounge room, after using the Pre-amplifier.

An alternative in this situation, would be to first try the provision of two or more similar antennae, suitably coupled, as with the CA16 harness. By utilizing their added performance matched into a very low loss coaxial down lead, say DSC21, the additional gain of 2.5dB. which is achieved from an antenna pairing, would, having travelled down 36M. of such a feeder, give in effect the same quality picture as could be viewed at the tower's top.

In very remote situations, the use of even quadruple arrays of antennae, does not always produce enough signal for this method to be effective, so, additional pre-amplification then remains the only alternative.

Stacking of antennae to improve gain is one thing, however, in many metropolitan situations the often poor quality of reception calls for a solution which is not always available from the utilization of a single antenna.

While an ideal antenna is developed to have only one narrow frontal receiving lobe, together with an infinite back-to-front ratio, in practice this is impossible to achieve.

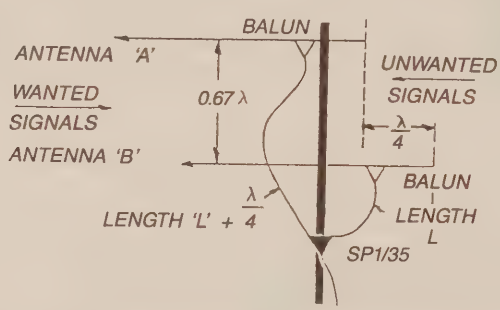
Back to front ratios are in the order of 20dB., while several small side lobes persist where widebanded antennae are concerned.

So, if unwanted signals are generated by the reflection of energy from local buildings or adjacent hillsides, the single antenna absorbs this unwanted energy, this in turn results in the production of ghost affected pictures at the receiver.

This situation may be averted or the effect substantially reduced by using **TWO** antennae which are suitably coupled.

1.9.1. Vertical Stagger Stacking to Reduce Ghosting.

Fig 1.0



If two like antennae stacked vertically, but with the upper antenna advanced towards the direction from which the required signals are to be received, it is a simple matter to allow for this "**STAGGER**" distance to be equal to λ/4 to the frequency which is to be rejected from the rear.

Now, if the screened feeder from the upper antenna, is made λ/4 longer than that from the lower antenna, at the point where the two feeders are brought together in a combiner, it will be seen that one received signal will be 180 degrees out of phase with the other.

To further explain this stacking procedure:-

If two antennae are called A & B, signals from the front of antenna A arrive one quarter of a wave-length before those arriving at antenna B, however, as the length of coaxial feeder to antenna A, is longer by the same increment, the signals from both antennae arrive in phase at a common combining point, (antenna combiner or SP1/3.5 etc.). So an expected increase in the received signal level of some 2.5dB. should be achieved.

At the same time, signals which arrive from the rear impinge first on to antenna B, by one quarter wavelength with respect to antenna A.

The extra cable length fitted to antenna A, increases this situation by a further quarter wavelength. Hence, at the afore mentioned combiner, the signals which arrive from the rear are 180 degrees out of phase and would in point of fact cancel each other out.

Dependent upon the physical accuracy of alignment and the cutting of the cables to length, an infinite Front to Back ratio can be produced for this antennae combination.

Please note that the velocity ratio of the particular cable used should be allowed for in all calculations used in stacking.

The quarter wavelength stagger of the antennae is a free space distance, while the quarter wavelength of cable is affected by the velocity ratio of the cable.

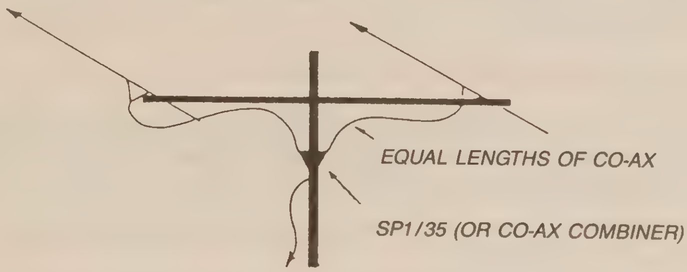
This method of stacking is effective for signals received from directions of up to **15 degrees on either side of rear boresight.**

While this method of stacking is most effective to the channel for which the stagger was designed, increased protection is also provided for other near channels.

For instance if the stagger was designed to reject reflected channel NINE signals, a significant degree of protection would flow-on to Channel SEVEN and TEN.

1.9.2 Horizontal Stacking to Reduce Ghosting.

Fig 1.P



While two antennae may be stacked to produce extra gain, in either the Vertical or Horizontal plane, apart from the physical relationship which is involved, that of not being in direct contact, the Horizontal distance the two antennae are apart is not critical. There is however, a directional property which is created by this horizontal relationship, which is of great value where we are required to combat ghosting.

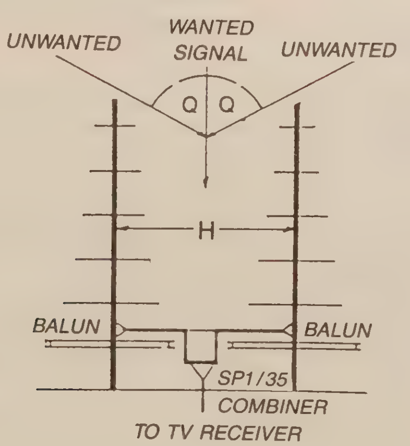
To reject an unwanted (ghost) signal on any Channel, two antennae may be stacked horizontally utilizing a specific separation distance, so as to modify the beam pattern of a single antenna.

This horizontal distance is derived from the following calculation.

$$\textbf{H (The HORIZONTAL STACKING)} = \frac{\textbf{Wavelength of the Unwanted Signal}}{\textbf{2 x Sin Q}}$$

Where **Q** is the angle between the direction the wanted signal arrives from, as compared with that from which the unwanted (ghost) signal arrives.

Fig 1.Q



If the two antennae are then connected from their take-off points to a common collector by way of equal lengths of identical co-axial cable, the signals which arrive at the array from the wanted direction will be **IN-PHASE** and so will augment one another, while those from the unwanted direction will be out of phase and so they will cancel one another out.

In point of fact, this arrangement has created a combined antennae pattern, which has four reception nulls, one in each quadrant. (Due to the Sine of the angle being the same for the complementary angles).

This method of stacking is very effective where the angle **Q is between 10 and 170 degrees on either side of the required antenna bore-sight.**

Due to the involved wave-lengths for Band 1 signals, this stacking method is more practicable where Band 3 or UHF signals are concerned. The increased distances do not effect the degree of signal suppression which can be achieved, but it may mean that the two antennae must be mounted on separate masts to provide for the separation.

1.10 Transmission Lines.

For an antenna to provide the best results, it should be designed to receive the required frequency coverage, have suffiient gain, reject unwanted signals and of optimum importance, provide for excellent matching between it's driven elements and the feeder system.

For, if this is not achieved, little of the signal voltage which has been gathered by the antenna, will be transferred to the adjacent TV receiver.

Historically, such a feeder system was achieved by the utilization of 300 ohm twin balanced ribbon feeder.

This was connected directly to the Take-Off assembly of a folded dipole.

It is now far more common to make use of some form of 75 ohm unbalanced co-axial feeder cable.

Because of it's constant impedance, ease of installation, longevity and the screened nature of its construction, which deters the pick-up of local interference, it forms a very satisfactory medium.

To convert the balanced output of the antenna, to the unbalanced format of the co-axial cable a BALUN transformer is required.

This product comprises a ferrite core on which are wound two coils, one of which provides a four to one ratio to the other. This unit is often supplied as part of the antenna assembly.

1.11 Co-axial Cables Used For The Reception and Reticulation of Television Frequencies.

Co-axial cables come in many different sizes and utilize many different contructional methods.

They have, however, the same fundamental purpose! To transfer signal voltages without due hindrance from source to load, while keeping such voltages clean from interference, or introducing distortion.

A co-axial cable is constructed, as its name implies, in concentric layers about a central conductor.

All co-axial cables maintain the following parameters:—

1. **Characteristic Impedance.**
2. **Attenuation.**
3. **Return Loss (Structural).**
4. **Screening Efficiency.**

1.11.1 Characteristic Impedance

The Impedance or AC resistance of a unit length of co-axial cable is determined by its physical configuration.

The **RATIO** between the overall diameter of the inner conductor and the overall diameter of the outer conductor, or screen, remains as near a constant as is possible, for any given type of co-axial cable, if the nature of the dielectric material does not change.

For example:— In a range of American cables where the inner conductor is composed of copper covered aluminium and the outer conductor consists of solid drawn aluminium tube, the dielectric is formed from a gas blown poly-foam material.

For cable sizes, which range from 0.412 ins. to 1.00 ins. in overall diameter, the ratio between inner and outer conductors is a constant 4.5:1.

This ratio provides for a range of cables with a characteristic impedance of 75 ohms and may be adjusted to provide impedances of 50, 80, or 92 ohms, or any other, if there is a requirement for such a product to be manufactured.

In the reception and distribution of Television signals we restrict ourselves to an impedance of 75 ohms.

1.11.2 Attenuation.

Every unit length of co-axial cable resists the transfer of signal voltages from one end to the other.

This absorption, or attenuation, is dependent upon the frequency, the physical dimensions of the cable and the style of dielectric material which is employed.

For the lay-man, in general terms, "**THE THICKER THE CABLE THE LOWER IS ITS ATTENUATION FACTOR**".

This of course may be misleading as it holds good only when the dielectric materials are comparable.

Attenuation is decreased when the DC resistance of the inner and outer conductors is lowered.

Hence large cross sections of low resistivity materials are utilized.

While gold or silver would make excellent conductors, copper, aluminium or copper coated steel are preferred, due to their distinct cost advantage.

In order to keep the two conductors apart, we employ some form of insulation. This we call the **DIELECTRIC.**

If it were mechanically possible, the dielectric we would choose to utilize would be AIR, as this would provide the best dielectric material. However, this is not practical, so instead, we make use of some form of easily extrudable plastic material.

In the most expensive types of co-axial cables, ceramic disks spaced at intervals provide the required mechanical support, but for the most part, polythene spirals, multi cell air spaced extrusions, blown plastic foam or even solid polythene is employed.

As most common cable types are produced by a system of extrusion stages, where one layer is extruded over the previously created layers, the dielectric materials need to be easily extruded if manufacturing costs are to be kept to a minimum.

As you can see a compromise is required when you come to select your cable.

In general, foam derivatives make for lowcost "**Downleads**" in both domestic and MATV installations, while MATV Trunks and Supertrunks are best served by "Air spaced" or American cable TV types.

In all applications make sure that the cable chosen is designed to cover the frequency range which you require to distribute.

Some cables Roll-off very rapidly over 600 Mhz., so, if your system is to reticulate Band 5 channels, the final levels may be adversely affected unless you have chosen the correct cable type.

1.11.3 Return Loss Ratio/Structural Return Loss.

This is a measure of the quality of the co-axial cable, or more importantly a check on the quality control of the manufacturing process.

Any imperfections which have been "built in" to the cable during the various extrusion procedures, by, say power surges, extruder deformation etc. create minor imperfections, which when the roll of cable is "Swept" during quality assurance test, shows up as Dropouts on the XY recorders curve.

In each production batch sample rolls are subjected to tests to establish on going quality standards. The check rolls are swept over the published nominal frequency range for the cable under test.

The test equipment is first set-up and with the use of a fixed 75 ohm bridge, where a resistive load doubles for the cable under test. Once the equipment has been equalized, the cable to be tested is substituted for the resistive load and the output of a sweep generator is injected into the bridge. When the cable is swept, from say 5-900 Mhz., the wavefront which passes down the cable, is compared with the reflected wavefront. The resultant ratio is displayed on a recorder which has been calibrated (in dB.) and is called the RLR.

Any production defects show up as deviations from the nominal impedance and are indicated on the recorders trace.

The test procedure employed to measure this parameter is a "bone of contention" between European and American manufacturers. In the same way that TV standards were developed in isolation so this test procedure employs a different method to obtain the published cable RLR.

In Europe where a FIXED bridge is employed, any variation in impedance from the nominal 75 ohms, affects the resultant RLR. As the cable may in fact have an impedance of 73 to 77 ohms and still be to published specification, the published figures reflect this rigid conformation to European standards.

American manufacturers, in their version of the same test, employ a variable bridge in lieu of the fixed bridge used in Europe. This allows for the bridge to be optimised to the average impedance. i.e. the bridge may be set to 73 ohms if that is how the manufactured sample turned out.

The result of this practice is to produce **"ON PAPER"** a better cable, at least as far as the RLR is concerned. Howbeit the American cable industry has only recently changed its upper frequency cable limits from 450 to 600 Mhz. and although it often claims that its cables have an RLR of 26dB. at UHF, this presumably does not extend to Band 5 frequencies.

1.11.4 Screening Efficiency

All co-axial cables have their outer conductor in the form of a shield or screen to resist the ingress of local interference, which may come from any number of Electrical or Electromechanical sources. Fluoro fittings, Lift motor switch gear and motor car ignition systems to name but a few.

Down lead styles of cables in particular, have a wide range of screening efficiencies. A single Braid is often made with a very loose weave which offers a minimum of shielding.

Other types use aluminium film on a plastic base, with or without an additional braid. More expensive cables employ copper tape which is over lapped and then covered by a substantial copper braid. This provides for some 98dB. of rejection to RF noise, while the extruded aluminium tube types, claim to provide in excess of 120dB.

Generally the more screening efficiency is improved, the more the cost of the specific cable will increase.

1.11.5 Choice of A Cable

In general terms, cables which are to carry Trunk signals, or where high signal levels are normal, should have a very low attenuation factor. Otherwise, the signal voltages are attenuated and additional cost must be involved in the provision of sufficient amplification to cover a specific geographic area.

Coincidentally such cables have the best screening factors and overall performance. It is not therefore, of any surprise that they also have up-market price tags.

In small systems where attenuation is less of a problem, or in Spur feeder situations on larger systems, a middle of the road cable such as **Hills DSC2i,** is a sound choice, as this cable also maintains all of the other parameters which are exhibited by the lower loss Trunk equivalents.

For feeder cable runs to TV outlets in Tee fed networks, or where the involvement of looped designs is deemed essential, **DSC32** maintains the high standards required while providing a flexible medium priced cable.

While Domestic installations should ideally employ the same double screened cable, we all realize that this segment of the market is the most cost conscious, so compromise must sometimes be made.

Do what you can to maintain quality, in all the materials that you use. Cheap cables often do not work well at UHF, while many have been know to have a very short life span.

Remember, the profit made during the installation can be quickly lost if service calls are required to overcome system defects.

Section Two

TELEVISION SYSTEMS

2.1 System Calculations.

Leaving aside the tree Cable Networks which are to be found in the USA and Europe, where whole cities are serviced by a single continuous network, the requirement for a mathematical evaluation in the design of systems, is very limited.

We do however require a full knowledge of the methods utilized in the calculation of system losses, cable attenuation, component through losses etc., so for the purpose of this section we will restrict ourselves to the use of the decibel in RF engineering.

Not to be confused with the use of the term to measure the level of SOUND intensity, our Decibel has purely mathematical function.

2.2.1 Decibels.

The decibel (abbreviated dB.) is a logarithmic unit used in Communications Engineering to express Power Ratios.

If the powers being compared are given the identity

P_1 & P_2 then:—

$$\text{Decibels} = 10 \log_{10} \frac{P_2}{P_1}$$

The Decibel has no other significance, so, if used to express an amount of amplification, this simply means that the presence of the amplifier in a system increases the level of the signal in the system by the dB. gain which is apportioned to that amplifier.

Resultant formula is:

$$10 \log \frac{25}{.25} = 10 \times 2 = 20\text{dB}$$

Under many conditions relative power is proportional to the square of the voltage E or current I etc. so:—

$$\text{Decibels} = 20 \log_{10} \frac{E_2}{E_1} \text{ or } \frac{I_2}{I_1}$$

These relationships must be used with caution however, as they only apply if the impedance remains constant.

For our purpose we use dB. as a ratio, but relate it to a microvolt or millivolt for the purpose of comparing the levels of signal voltages.

So, if we relate to one microvolt, as in Victoria:—

60 dBu Volt = 1000u Volts (1 millivolt)

120 dBu Volt = 1 Volt (1,000,000 microvolts)

Some States prefer to relate to 1 millivolt, as this is often the specified level to produce a good clean picture in a distribution system.

So if we relate to 1 millivolt:—

−60 dBmV = .001 mV or 1 uV

while + 60 dBmV = 1 Volt

Please refer to the adjacent dB. chart

Example: To find the output level in millivolts of an Amplifier which has a published Gain of 26 dB. if a signal of 5 millivolts is inserted.

5 millivolts (Input) = 20 Log 5 = 13.9794 dBmV.
Add 26 dB. = 39.979 dBmV. Divide by 20 = 1.99897
From the Anti-Log of 1.99897 we obtain 99.763 mV.

Which is the output level of the Amplifier.

2.2.2. dB CONVERSION TABLE — SEE PAGE 25

AT 127 dBuV - CAN USE ANT. GAIN OF 9dB + COAX LOSS FOR .5W ERP.
FOR .5W EIRP, 7dB ANT GAIN + COAX LOSS.
BT4-UHF3B HAS 8db3 gain/dipole

dB CONVERSION TABLE

Voltage microvolts	dBmV	dBμV	Voltage millivolts	dBmV	dbμV	Voltage millivolts	dBmV	dBμV
10.00	−40	20	1.0	0	60	112.2	41	101
11.22	−39	21	1.12	1	61	125.9	42	102
12.59	−38	22	1.26	2	62	141.3	43	103
14.13	−37	23	1.41	3	63	158.5	44	104
15.85	−36	24	1.59	4	64	177.9	45	105
17.78	−35	25	1.78	5	65	199.5	46	106
19.95	−34	26	2.00	6	66	223.9	47	107
22.39	−33	27	2.24	7	67	251.2	48	108
25.12	−32	28	2.51	8	68	281.8	49	109
28.18	−31	29	2.82	9	69	316.2	50	110
31.62	−30	30	3.16	10	70	354.8	51	111
35.48	−29	31	3.55	11	71	398.1	52	112
39.81	−28	32	3.98	12	72	446.7	53	113
44.67	−27	33	4.47	13	73	501.2	54	114
50.12	−26	34	5.01	14	74	562.3	55	115
56.23	−25	35	5.62	15	75	631.0	56	116
63.10	−24	36	6.31	16	76	707.9	57	117
70.79	−23	37	7.08	17	77	794.3	58	118
79.43	−22	38	7.94	18	78	891.3	59	119
89.13	−21	39	8.93	19	79	**Volts**		
100.00	−20	40	10.00	20	80	1.00	60	120
112.2	−19	41	11.22	21	81	1.12	61	121
125.9	−18	42	12.59	22	82	1.26	62	122
141.3	−17	43	14.13	23	83	1.41	63	123
158.5	−16	44	15.85	24	84	1.59	64	124
177.8	−15	45	17.78	25	85	1.78	65	125
199.5	−14	46	19.95	26	86	2.00	66	126
223.9	−13	47	22.39	27	87	2.24	67	127
251.2	−12	48	25.12	28	88	2.51	68	128
281.8	−11	49	28.18	29	89	2.82	69	129
316.2	−10	50	31.62	30	90	3.16	70	130
354.8	−9	51	35.48	31	91	3.55	71	131
398.1	−8	52	39.81	32	92	3.98	72	132
446.7	−7	53	44.67	33	93	4.47	73	133
501.2	−6	54	50.12	34	94	5.01	74	134
562.3	−5	55	56.23	35	95	5.62	75	135
631.0	−4	56	63.10	36	96	6.31	76	136 0.5 WATTS
707.9	−3	57	70.79	37	97	7.08	77	137
794.3	−2	58	79.43	38	98	7.94	78	138
891.3	−1	59	89.13	39	99	8.91	79	139
1000.00	0	60	100	40	100	10	80	140

1000 microvolts = 1mV = 0dBmV = 60dBμV = GOOD PICTURE

-41 - 8.91 19
-42 - 7.94 18
-43 - 7.08 17
-44 - 6.31 16
-45 - 5.62 15
-46 - 5.01 14

-47 - 4.47 13
-48 - 3.98 12
-49 - 3.55 11
-50 - 3.16 10

2.3. Typical Reception Problems

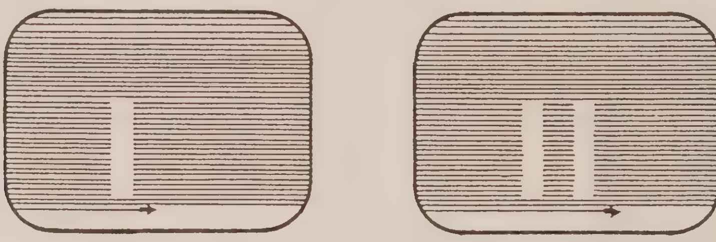
While you have selected the Antenna which is best suited to the location of your current installation, utilized and terminated your co-axial cable in line with good engineering practice, the resultant picture may leave much to be desired.

This section is dedicated to the explanation of and rectification, if possible, of the picture defects which are to be found in all too many installations.

2.3.1 Ghosting.

The image that we see on the screen of our TV receiver is produced by a series of dots of light which are caused to move from Left to Right across the screen. They vary in intensity, in shades of Grey, from Black to White, according to the Video information which is contained in signal voltages which control the variation. If the same information, is again fed to the receiver, but after a short delay, a second image will be produced on the screen, to the right of the first image. See *Fig 2.A.*

Fig 2.A.



There are several circumstances which can cause this delay to occur. One such delay is created when some of the signal voltages are delayed in their path from the Transmitter to our Receiver. In such a case the delayed signal arrives at our antenna later than the majority of the signal to produce a second, or multiple images.

VHF/UHF radio waves, can be REFLECTED, REFRACTED, or ABSORBED, as they pass through space.

2.3.2. Reflected Waves.

The VHF/UHF waves may be likened to a beam of light from a beacon.

In the same way that a beam of light, which strikes a mirrored surface is caused to reflect from the surface, at the same angle as that at which it strikes the object, so a radio wave reflects from the side of a building or any solid object.

To effectively reflect horizontally polarized waves, an object needs to be approximately half the wavelength of the passing wave.

So, any object greater than this in width, will provide a reflecting surface.

Signal energy is lost during the reflection process.

The degree of this loss is determined by the conductivity and profile of the reflective surface. The nearer this resembles a mirror, the lower is the level of signal which is absorbed.

The wavefront now being reflected on to our receiving antenna, has been delayed in time, due to the longer path which it has taken, when compared with the direct wave.

It has also lost more energy than the direct wave, so is of a lower comparative level.

2.3.3. The Ghost Image.

A reflected wave of sufficient strength can result in the display of a second image on the screen, whose separation from the directly received image is determined by the additional path length.

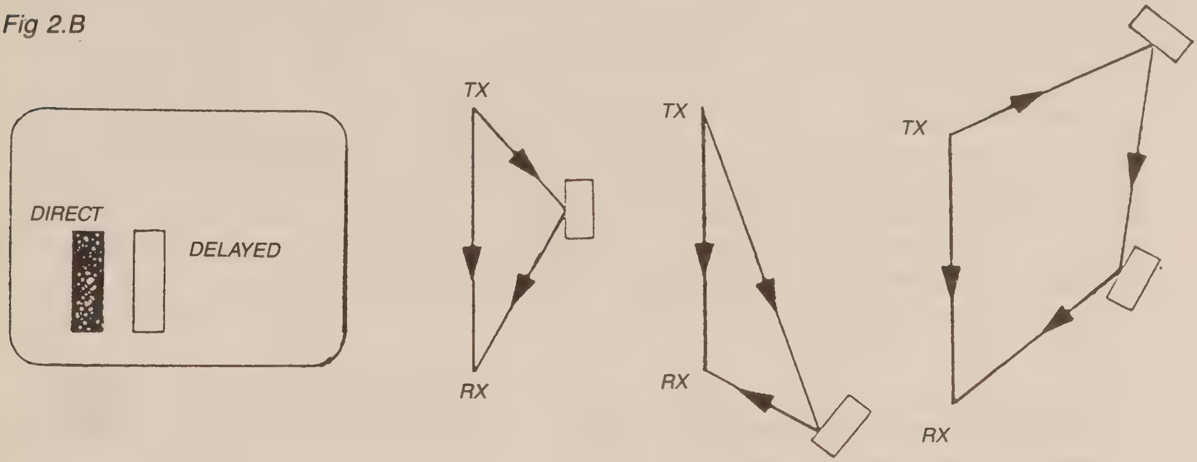
It is this effect which is termed **ghosting** and the weaker image is referred to as the **GHOST.**

Dependent upon the severity of the ghosting and the angle from which the unwanted signal arrives, use may be made of the stacking methods which were described in a previous section.

2.3.4. Trailing Ghosts.

Due to the fact that the ghost signal is provided by the delayed signal, it will arrive at a later time and therefore will be displayed to the right of the direct signal on the receivers screen. For this reason it is known as a trailing or lagging ghost. See *Fig 2.B*

Fig 2.B



This is the more normal ghost which is to be seen on a domestic TV receiver, where the distance from the receiving antenna to the TV receiver, does not exceed 20 Metres.

Above are shown three of the typical situations which give rise to the Trailing ghost.

2.3.5. Leading Ghosts.

It is possible, on the other hand, in an MATV system, to experience a leading ghost, which precedes the main image which is produced from the system's antenna.

A function of the system's co-axial network, briefly dealt with under **Co-axial Cables,** is that it transfers RF energy at a speed which is somewhat slower than the speed of a radio wave in free space, (3×10^8 Metres/Sec).

This function of the cable, it's **VELOCITY RATIO,** is found to be in the order of 0.8 to 0.87. So the signal voltages are delayed by the function of the co-axial cable, when compared to signals received by direct **OFF-AIR** radiation.

In an MATV situation, in an area which is close to the transmitter, the TV set's FLY—LEAD, or indeed the input feeder to the set's tuner, will pick up directly radiated signal voltages, which arrive in time before those which are transferred by way of the cable network.

The direct signal's synchronizing pulses, which are part of the composite transmitted signal, trigger the Line timebase, so starting the display procedure.

Some time later, the same sync pulse, provided via the ditribution system, arrives and once again attempts to initiate the sequence.

In HIGH-RISE situations, the OFF-AIR signal may be many times stronger than the 0 dB/mV. level which the common design calls for and which is provided via the cable network.

Where the two signals are of equal or near equal level, it is often possible to increase the levels on the system via additional local amplification, which will rectify the problem. Where this is not practicable, or where the level difference is extreme, the only solution is to cause the frequency of the Off-Air signal to the system, to be frequency translated in the Head-End arrangement.

In this way, all of the Off-Air channels are converted to at least adjacent allocations, so that the set's tuner may act as a deterrent to the leading ghosting.

This form or ghosting is in some ways worse than that observed from the reflected ghost, for, with a colour set the trailing ghost displays an effect which may be difficult to detect, unless the picture content has a large amount of contrast, or if the subject is slow moving, as in the viewing of a cricket match. The **Leading Ghost,** on the other hand tends to change the phase relationship of the signal and in doing so provides for a change in the picture colour which is produced.

For instance, the left side of a woman's face, as viewed, if the subject has black hair, may have a bright orange line on the side of her face. The width of the line being determined by the time delay between the two signals.

2.3.6. Receiver Sync.

The receiver will usually LOCK-ON to the synchronizing pulses of the stronger signal which is being received, inrrespective of it's time of arrival. Two signals of equal, or near equal strength can cause the apparent loss of Sync.

The result, to the receiver may be vertical rolling or jitter, or horizontal pulling or jitter.

Steps should be taken to increase the signal level, or to frequency translate as previously outlined.

2.3.7. Ghosting in Close Proximity to the Transmitter.

At any given point within the reception area of the transmitter, as well as the direct waves from the source, countless reflected waves will also be present.

Because of the loss of energy during the reflection process, most of these reflected signals will not appear on the set's screen as defined ghosts.

Instead, they can effect the picture quality by causing a **SMEARING,** or lack of focus effect.

Some reflected waves will have travelled by only a minute extra distance, so they will appear on the screen at the same time (but not quite).

In this way they become superimposed on the main image. The result is again a lack of picture quality, with blurred edges and a general lack of sharpness to the picture.

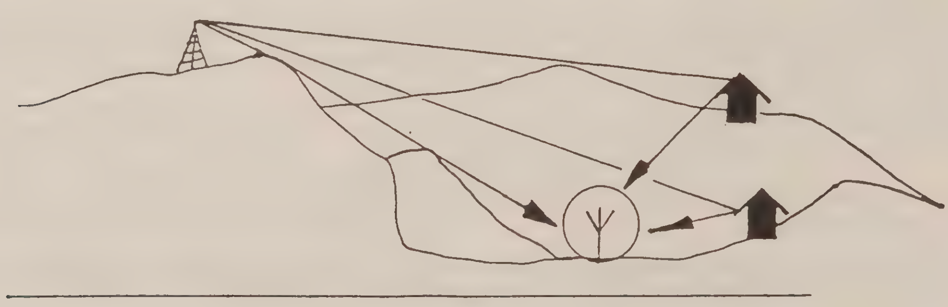
In this situation it may be expedient to select an antenna which has excessive gain for the location, but has better anti-ghosting properties.

2.3.8. Ghosting in Difficult Areas.

"Difficult Areas" are in general those behind hills, which are sheltered from the direct wavefront of the transmission, but subject to many reflections from hills, buildings and other structures both at the sides and from behind.

Similar situations exist behind high-rise blocks and silos or gasholders, if any now exist. See *Fig 2.C.*

Fig 2.C.



In such difficult areas, very little direct signal may be received, so the many reflected signals, previously of negligible strength, now assume greater importance.

The screen will show evidence of many ghosts, produced by a variety of signals with many different delay times.

The strongest signal will be selected by the receiver and locked on to for synchronization.

As this signal may have a delay time longer than some of the other signals and shorter than others, the resultant will be a series of both leading and lagging ghosts.

2.3.9 Delayed Sync Pulses.

Where greater differences in delay times exist, a further problem may be observed.

If the sync pulses of a number of signals are of sufficient strength, the sync pulses of signals which arrive well before, or well after the signal to which the TV set "locks", will cause all the pictures to appear on the screen at the same time.

These sync pulses would normally arrive during the retrace period of the signal spot, if the set was locked to them, so they would be blanked out.

If the set is not locked to them, they will appear during the travel of the spot across the screen and so, they will be superimposed on the picture material.

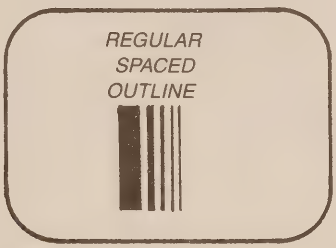
They will subtract from the brightness of the picture material and show as vertical streaks from top to bottom of the screen. Their edges will be more apparent, because of the senstivity of the human eye to changes in brightness levels.

In a bad ghosting area, many sync pulses of differing strengths, can appear on the screen and give the appearnce of a striped curtain.

2.3.10. Ringing.

An effect sometimes mistaken for ghosting is **Ringing.** This problem was/is caused by faulty alignment of the IF strip in Black and White receivers of a previous age, or in that era by faulty receiver design. With ringing, a series of evenly spaced and progressively fading lines occur near the right hand edge of dark objects. See *Fig 2.D.*

Fig 2.D.



We still refer to this effect as some installers may experience a Black and White receiver during the course of their business. As, however, the IF strip of the current Colour receiver in most cases is comprised of a S.A.W. filter and even earlier colour models had reverted to a single fixed tuned circuit, this problem will now be a rare experience.

2.3.11 Transmission Line Pick-up.

Any transmission line, be it the distribution main trunk, or a domestic downlead, should be free from Standing Waves. That is waves caused by the interaction of forward travelling wavefronts and reflected waves.

The cause of these waves, is either derived from defective components, or faulty cable installation.

Random pick-up of ambient wave fronts by the feeder in these situations, will result in picture instability.

The effect may be easily determined by running your hand down the length of the Fly-lead.

The added capacity provides for the installation of a STUB filter to the system, which is frequency sensitive.

Hence the picture will appear near normal or disappear, as the Flylead is traversed.

Check for faulty cable connections or defective Taps or Splitters.

2.3.12. Signal Additions and Subtractions.

As the transmitted signals travel from their source to the receiving antenna, they may be combined with reflected waves to form a composite wave.

Due to the phase relationship between these different waves, the combined signal may be caused to add or subtract in total level. Taken to the extreme, this could result in total cancellation of the signal.

This phase change, together with certain delay times, can also result in selective frequency cancellations. This can be broad or narrow and can attenuate the entire, or a small frequency segment of the channel.

Dependent upon the exact frequency at which the cancellation occurs, a loss of sync, sound or colour, or indeed the deterioration of the picture as a whole may occur.

2.3.13. Distance From The Reflective Object.

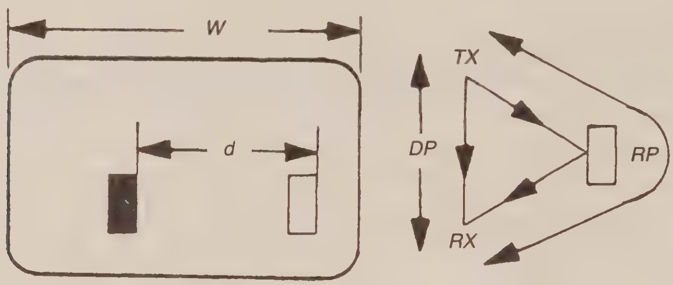
The repeated spot, which forms the basis for the viewed picture, takes approximately 50 microseconds to travel across the screen from left to right.

This is irrespective of the size of the TV screen.

By measuring the displacement of the delayed signal on the screen, See *Fig. 2.E.* and knowing the speed of the received wave, we can calculate the extra time which is involved between the arrival of the main and ghost wave.

This in turn will indicate the extra distance the ghost wave has covered.

Fig. 2.E.



$$RP - DP = \frac{14{,}880 \times D}{W}$$

where w = the screen width.

Therefore, with a 53 cm. set, which has a screen width of approximately 47 cm., a displacement of 2.54 cm. will equate to an additonal distance traveled of 804 m. or 64 mm. will infer an additional 200 metres.

$$\frac{14{,}880 \times 2.54}{47} = 804\ \mathrm{M} \qquad \times \qquad \frac{14{,}880 \times 0.64}{47} = 200\ \mathrm{M}$$

Please remember this is the additional path length to provide the ghost. The reflecting surface could be in any direction from your antenna. In fact, it could be at any point on the locus of an ellipse drawn with the transmitter and receiver at its focal points.

2.4 Systems Hardware.

Having looked in some depth at the factors which go to influence our selection of system's antennae and the type of transmission line to utilize, some time should now be dedicated to the introduction of other hardware, both active and passive, which is required to provide for a distribution network.

As all passive components in any network may be regarded as "signal eaters", whether this is caused by inbuilt attrition, as in the case of co-axial cable attenuation, or by intent, when Taps and Splitters are introduced, it is a fact that the signal level which was gathered at the antenna terminals, would, in most applications, be insufficient to provide pictures of adequate qualtiy without some assistance.

2.4.1 Amplifiers.

The received signal, may be amplified in several different areas of a TV distribution system.

It is the intent of this section to discuss the merits of the various types which are available, in the order in which they may be expected to appear.

2.4.1.1. Mast-head Amplifiers.

A Mast-head Amplifier is very different from all other types. As the name suggets, the amplifier is, in the main, located in close proximity to the antenna and in many cases at the top of a mast or tower.

At least this was the case in the early days of television in Australia.

Transmitters were located in metropolitan areas or large country centres, so large areas of the Commonwealth had no TV service they could call their own.

To obtain at least some of this metropolitan fare, large antenna arrays were required.

These were mounted in the main, atop high masts or towers. One hundred foot structures were quite normal, fifty miles from the transmitter. So, in order to receive any signal at all, the antenna was placed further and even further away from the TV receiver.

At this time the only co-axial cable available in Australia, was of questionable quality as it's through loss was in the order of 8 dB. per hundred feet at 200 Mhz.

An amplifier mounted adjacent to the antenna with enough gain to overcome the cable losses, with a bit to spare, was all that was required.

Some older readers may well remember the Hills "Redhead", with it's single transistor stage and 13 dB. gain.

One factor which must be recognised, is that, while all systems components, even the antenna, add NOISE to the signal to noise ratio of a system, the introduction of the first amplifier adds a much greater proportion of the total added noise, than any other component.

So, it is essential when you select a Mast Head amplifier that you opt for a unit with the lowest NOISE FACTOR and not one with the highest gain.

Market pressure has led to such amplifiers having higher and yet higher gains; 20, 26, 30, 36 dB.

However, with the introduction of high quality co-axial cables, where a typical 30 metre downlead, would not exceed 2.5 dB. of loss, this excessive gain is not warranted.

These amplifiers should however, posses a high output capability, in order that it can cope with any strong local signals.

This however, is not a parameter which requires high gain, in fact the opposite is the case.

2.4.1.2. The Power Supply Unit.

While the "mast-head" mounted amplifiers, require a DC voltage "rail" of some 12-24 Volts to power them and such DC voltages are sometimes provided directly via the co-axial cable, it is more common to provide an Alternating voltage supply which is rectified and smoothed in the Head unit.

Such a method reduces corrosion to the involved connectors and may be filtered at each end of the co-axial downlead to separate it from the amplified signal voltages.

It is common now to provide the required mains to low voltage transformation, together with downlead connection and the TV set's flylead connection, within a plugpack. This unit is inserted directly into any convenient mains service outlet.

2.4.1.3. Static Discharge.

Due to the exposed position of many mast-head amplifiers, they should be designed with gas discharge by-pass circuits and shunt diode protection of all transistor stages.

Such steps will nullify the effect of high levels of static discharge which are common to many of our climatic regions.

Even direct lightning strikes to the associated antenna may be withstood, if the mast structure is properly earthed.

2.4.1.4. Mast-head Amplifier Versions.

From the days when the main purpose of this amplifier was to boost Band 3 signals, versions are now available which select individual bands, the VHF Band, UHF Band, or the entire TV Band from 40-860 Mhz.

It should be obvious that while an antenna is designed to promote certain specific channels, it is not a "switch", so any unwanted signal, two way radio, etc., which is of sufficient strength may be picked up and relayed to the system's mast-head amplifier. So, it is important to select the amplifier which is best suited to your individual requirements and to keep the bandwidth as narrow as possible to restrict such unwanted amplification.

2.4.2. Single Channel Amplifiers.

While the current crop of pre-amplifiers are at the best bandized, it is important, where high system launch levels are to be generated, that the individual channels should be processed by an individually dedicated amplifier.

Such a product, which has it's bandwidth restricted to seven or eight Mhz., as determined by the employed TV system, may have a high gain of some 40-50 dB., while maintaining a high output capability. Typically this is in the order of 120 dBuV.

As MATV systems grow in complexity, it is essential that the output level of individual channels can be adjusted to provide a "ramped" output. That is, the output level at the highest UHF channel of a system should be a the system maximum level, while channels of a lower frequency in decending order, have their output levels restricted. In this way a slope or ramp may be placed on the composite output signal voltage.

This procedure has two objectives.

One is to provide for a better balance of signals at the system outlets, as the cable attenuation, being as it is, logarithmic in nature, would tend to reduce the higher frequencies in preference to the lower ones if this ramping was not employed.

The second, is to provide a FLAT input to any subsequent trunk or repeater amplifier which may be required. If this is not so, the strongest available signal, (without ramping this would be say Channel 2) would control the available gain, or introduce unwanted inter-modulation products, if the amplifiers output capability were to be exceeded.

While Off-Air signal level variations may not be a severe problem in metropolitan areas, it is however advisable to employ such a single channel amplifier with an A.G.C. facility, to maintain the required system level balance.

2.4.3. Trunk Repeater.

In medium to large MATV systems, it is common to have the need to reinforce the level of the Trunk signal, or to provide an amplifier to boost the signals to a floor or combination of floors in a high rise development.

Such an amplifier will have a moderate gain of some 25-30 dB., a high output capability of at least 114 dBuV and it should posses the facility to by-pass the VHF frequencies, if desired. The availability of a variable equalizer, or Slope control, is a distinct advantage.

2.4.4. Domestic Distribution Amplifier.

Used in small MATV systems, or larger domestic situations, this amplifier variety would have a gain of some 20-26 db., an output capability of 112 dBuV. and in most cases the option of multiple low level outputs.

Such a product can be employed as an active splitter, to provide signals to a number of outlets, in the larger home. the amplifier allows for smaller, less expensive antennae to be used in many cases. This is a distinct advantage where the ecological situation of the home calls for a minimum of outdoor disruption.

2.4.5. Passive Distribution Components.

The passive components utilized in any TV distribution system will be derived from the following:—

- **(a) Spitter**
- **(b) Trunk Taps**
- **(c) Distribution Taps**
- **(d) Filters**
- **(e) Equalizers**
- **(f) Outlets**

2.4.5.1. Splitters

A Splitter, as the name conveys, is a device which is used to split the composite TV signal into several different legs. These may produce equal splits of two or four ways, or unequal splits as the system design dictates.

2.4.5.1.1. Two Way Splitter.

The two way splitter is in effect a power divider, as it produces a loss to each of it's Spur legs of 3.0 dB. when compared with the input signal level.

As the splitter is, in well designed products, comprised of a tapped ferrite cored transformer, an insertion loss of between 0.5 and 1.0 dB. dependent on frequency should be expected.

Earlier type resistive splitters should not be employed. While separating the input signal into two equal parts the splitter must also isolate the two Spur ports by at least 17 dB., to prevent interaction between the two legs.

2.4.5.1.2. Three and Four Way Splitters.

A three way splitter may produce three equal output levels, or one through output and two spur outlets. In this case the spurs are again split after the initial separation to produce a through output loss of 3.5 to 4.0 dB. and two spur losses of 7.5 to 8.0 dB.

2.4.5.1.3. Four Way Splitter.

The four way divider produces four equal separations of 7.5 to 8.0 dB., to each leg or spur.

2.4.5.1.4. Other Splitter Options.

Other splitter options to produce six, eight or even twelve equal spurs are available but the use of such products in MATV design is rare.

2.4.5.2. Trunk Taps and Directional Couplers.

Trunk Taps or uneven splitters are used in MATV design where the main or trunk signal path is required to be divided into two parts but where one leg will have low through losses, typically 1.6 dB. or less, while the spur port exhibits 8, 12, or 16 dB., of loss.

This device is a part of the main trunk network and is not to be confused with a Distribution Tap.

In American cable TV design, where the amplifiers are powered via the co-axial cable of the trunk network, such units must be able to pass this line power of 55 V. and cope with a line current of some 12 Amps.

2.4.5.3. Distribution Taps or Directional Couplers.

Distribution Taps are typically available in 2, 4, or 8 port types and are designed in a sequence of Side loss values at 3, 4, 5, or 6 dB. intervals.

Special Taps as used in Broadband Data Networks, may provide variable forward and reverse tap losses to suit this more exacting design requirement.

The onset of Intelligent, or at least two way capable, MATV systems, has created a requirement for all versions and side loss values of these distribution taps to be designed as Directional Couplers.

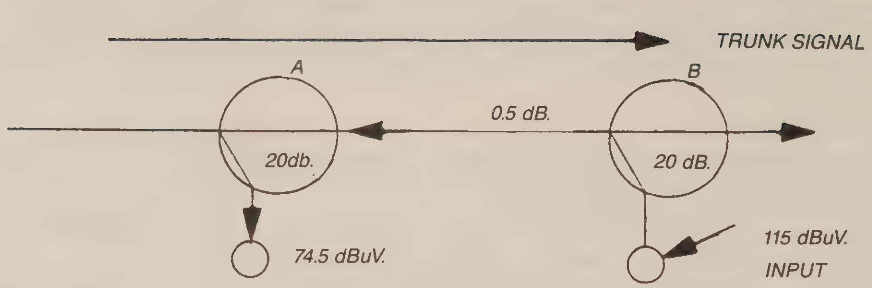
In the past, apart from in low side loss values, i.e. 12 and 15 dB. side loss units, where the isolation between the tap ports would have been typically 24 and 30 dB. (less than the Australian standard of 34 dB.), such distribution taps were in point of fact, transformer coupled units and did not posses directional properties.

When all TV signals on the distribution network were flowing from the Head End down to the respective outlets, this did not matter as the isolation of 34 dB. prevents any interaction between adjacent taps, or between adjacent ports of the same tap, as the signal levels were compatible.

With the introduction of signals in the reverse direction, i.e. from an outlet towards the head end, the level of such inserted signal voltages could be in the order of 115 dBuV.

In such cases, the return level from an adjacent DOWN STREAM tap would present the ouput with a signal of a much greater level. See *Fig. 2.F*

Fig 2.F



So, it is now common for all new and re-built systems, which may be called upon to work in a bi-directional way, to incorporate a Directional Coupler in the drop tap situation.

The fundamental difference between the two types of product is that in the Directional Coupler the IN to TAP Loss, which is in most cases the published Side Loss value ie. 2/20, 2/26, etc., differs from the OUT to Tap Loss value by the Directional property of the unit. This directional property is in the order of 10 to 15 dB.

As can be seen in Fig. 2.F. above, the input signals to the Tap A from Tap B would now be:—

Reverse Input to Tap B = 55 dBmV.

Less 20 dB. Side loss, Less 0.5 dB. Cable loss, Less Side loss of Tap A = 20 dB. Less Directivity of 10 to 15 dB.

So the level of reverse signals from Tap B to Tap A Would be between 4.5 dBmV. and −0.5 dBmV. dependent on the involved frequency.

2.4.5.4. Diplexers.

A Diplexer is a means to separate signal frequency bands, rather than signal levels, as with the Splitter.

The output of two filters tuned to pass a specific range of frequencies, different Bands or Channels, is combined and passed via common filter network to effect the required output matching.

Diplexers are avilable to combine, or split, if used in reverse, VHF from UHF, Band One from Band Three, etc. The only limit to any choice of separation, is the frequency gap which is required to effect the cross-over between the two filters.

This in turn, is determined by the rejection slope or skirts of each filter.

The sharper the response for each filter, the closer the two responses can be while maintaining the required degree of isolation. Cost however is a major factor, as a sharp response calls for a more complex filter arrangement, with inherently greater manufacturing costs.

2.4.5.5. Multiplexers.

Multiplexers are produced in the same manner as the Diplexers, but comprise three, four, or more separate filter elements. The same design parameters apply with even greater emphasis on the skirt rejection factor.

2.4.5.6. Equalizers.

Most passive components have a Through Loss which is constant irrespective of the frequency which is being passed through them, so long that this frequency is within the design parameters of the component. So, while the Channel allocations in a system may range from VHF Band 1, to UHF Band 5, the through losses will not change very much.

The same cannot be said for the involved Co-axial cable.

As we know the insertion loss of a cable increases sharply with respect to the applied frequency. A typical RG 6, shows for a one hundred metre length, a loss of 4.9 dB. at Channel 2 and 22.6 dB. at the top of Band 5.

So, we have a slope of some 17 dB. across the normal operating frequency spectrum of a typical cable distribution system.

An Equalizer is designed to combat this unwanted slope, by producing a filter network which provides little attenuation to very high frequencies, but considerable attenuation to low frequencies.

The ideal Equalizer would posses a variable network, which could be adjusted to cope with the cable length and is loss parameters, for, you will realize that no one fixed product would be ideal for all conditions.

2.4.5.7. TV Outlet.

The TV Outlet is the means by which the drop of "feeder" co-axial cable may be terminated in a convenient manner.

If you wish to connect a domestic antenna via the co-axial downlead and plug it directly into your TV receiver antenna socket, there is no technical impediment.

The outlet in it's basic format provides the interface between the downlead and a socket.

The socket may be Belling-Lee, F type, N type or BNC, or any other type which suits the user. Although it is more common to use either the Belling-Lee of F types.

In MATV work however, it is recommended that series isolation capacitors be installed in both the signal and return legs of the drop cable, to prevent the passage of possibly lethal voltages from outlet to tap or vice versa.

The outlet plate forms a convenient housing for such capacitors. In looped wired systems the outlet plates also contain the resistive network required to produce a graded signal level to such outlets.

2.5. Master Antenna TV System Design.

Master Anenna Television Systems are in the main dedicated to the distribution of RF signals throughout a single property, or property title.

As the name indicates, one antenna or a combination of antennae, are arranged to provide signals to a number of TV outlets, which are dispersed about the property in question.

The signals which are distributed by an MATV system, may be derived from terrestrial ground based transmitters, Microwave links, co-axial or optical fibre cables and In-house, suitably modulated video material. In addition FM or amplitude modulated signals may also be either distributed directly, or after frequency conversion.

2.5.1. S.M.A.T.V.

S (for Satellite) Master Antenna Systems, provide for the distribution of signals as before, however they add a new dimension in that they also source material via Satellite down stations. Such material is either "in the clear" or may contain channels which have been ENCODED to provide for a paid service. Suitable arrangements must be made in a SMATV system to allow for de-coding and the recovery of the involved service charges.

2.5.2. MATV System Segments

The MATV System may be divided into three basic segments.

1. HEAD END 2. MAIN TRUNK 3. DISTRIBUTION TRUNK

2.5.2.1. The Head End.

The name "Head-End" has the connotation of being at the top of a building.

This was the case, in most sytems, when only VHF services were to be distributed.

With the introduction of UHF services, expecially in high rise developments, the Head-End, is to be found located almost anywhere.

Typically they are located halfway between the Top and Ground floors, at least if the system has been designed by an expert in the field, as this location provides for the most economic use of available signals.

The Head-End may be found in Lift motor rooms, (NOT IN QLD.) main electrical or telecommunications ducts, or any convenient equipment cabinet. It provides the Hub for any form of distribution network.

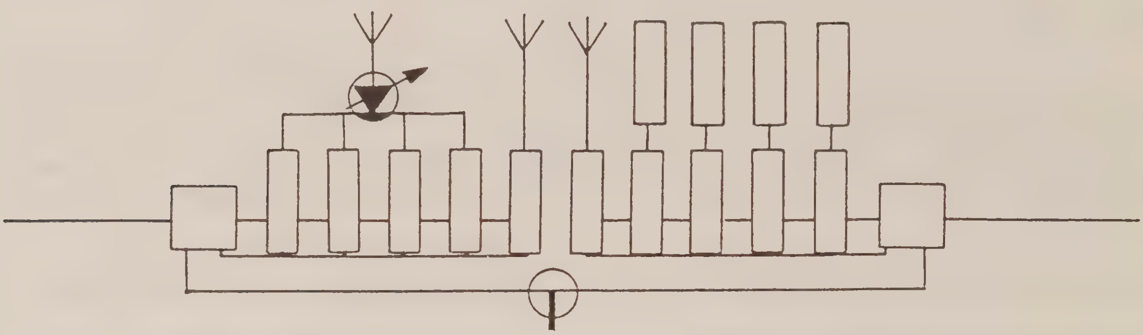
Signal feeds, either from discrete or combined sources, are transferred from the roof mounted antennae, satellite down converters or laser receivers, to the location of the Head-End. Here they are separated, filtered and balanced prior to being applied to single channel amplifiers.

As previously outlined under Section 2.4.2., the type of amplifier used will, in the main, depend upon the size of the distribution network.

In many systems however, it will now be comprised of a number of modular units, where high level signals may be produced prior to distribution.

A typical system could be as shown in *Fig. 2.G.*

Fig 2.G.



A series of modules, one for each channel which is to be distributed, will form the assembly.

The modules will be selected from a range of products, each dedicated to a particular purpose:—

Amplifiers

Frequency Converters

Modulators

Signal Processors

The end purpose being to provide a composite signal, which is able to distribute all of the received material, without interaction and at the individual level which is dictated by the system design.

The output of individual modules will be adjusted to provide a slope which is graduated from the highest to the lowest frequency which is to be distributed.

For instance :— **Channel 54 Output say 55 dBmV.**
Channel 2 Output say 36 dBmV.

With the intervening channels adjusted to obtain an integrated gradient.

If this is not provided, as the UHF channel levels attenuate during the distribution process, far more than the Low VHF ones, a gross system imbalance would be created at the distant outlets.

2.5.2.2. The Main Trunk.

The main Distribution Trunk will derive it's input from the Head End processor.

It will be comprised of low loss co-axial cable, to conserve signal levels and, by the use of splitters and single spur directional couplers, provide access to the distribution trunks and their associated subscriber outlets, at a level determined by the system design.

2.5.2.3. The Distribution Trunks.

Taking signals from the main trunk distribution components, the Distribution Trunk will maintain sufficient signal levels to be able to supply any number of drop taps which are distributed in series along the length of each trunk.

Such Taps will be situated adjacent to the individual, required service outlets. By the selection of suitable side loss values, the local distribution area and the system as a whole will be balanced to provide system level equality.

2.6. Design Practice.

In Australia the design of an MATV System may be separated into three basic areas:—

1. Low Rise (say up to 4 levels).

2. Multi Level High Rise.

3. Out door (Caravan Park, Marina, etc.).

As at the time of writing the introduction of Cable, or Pay Television in Australia, is still to be decided, (although much discussed over the last nine years), it is not our intention to elaborate on this facet of TV distribution.

The Design of a system may be carried out in two ways.

1. By calculating the signal level required to service a given building, by first adding the accumulated losses of Taps, Splitters and other circuit elements to arrive at a Drive Level requirement.
2. By providing a Drive Level, say in the form of a modular head end, which is then depleted as the design progresses. This level may be augmented as required by repeater amplifiers.

The two different approaches are in fact derived from different roots, but both are effective in producing workable systems.

2.6.1. European or Australian method.

As the Drop Tap variation may be determined with ease after checking with the building drawings and due to the pre-determined position of the outlets, it is convenient to provide a terminated end of line distribution tap.

Such taps are situated at the end of a passage way, away from the main trunk.

Their side loss value then determines the initial signal voltage which is required to service the adjacent TV outlet.

For example, where an adequate signal level of say one millivolt is required to service a nearby outlet, this level, plus an allowance for the insertion loss of the outlet plate, together with a further allowance for the length of drop cable, will determine the signal level required at the drop tap spur port.

Dependent upon the number of ports in each device, the terminated unit may be either an 8, 12, or 17 dB. side loss type.

So the initial required signal level will be the required spur port level plus the side loss value.

Having determined this end of line level, the next step in the system design is to determine the cable losses involved from the terminal tap to the next tap down the line.

This will be determined by the type of cable which is employed and by the upper frequency limit of the particular system.

As previously outlined equalization will be required to provide for a system balance, however at this stage it is sufficient to design at the upper frequency, unless a computer aided programme is being utilized.

The calculated cable loss will be added to the previously determined signal level.

This next tap will not be terminated and will have a published through loss, so, while adding this through loss to the previous sequence to provide the required signal level at it's input, the side loss must also be determined.

As the purpose of the design is to provide a balanced system, so far as the various outlets are concerned, all available side loss variables must be optimised to provide the best balance between this tap and the previous one, allowing for all the system losses which are involved.

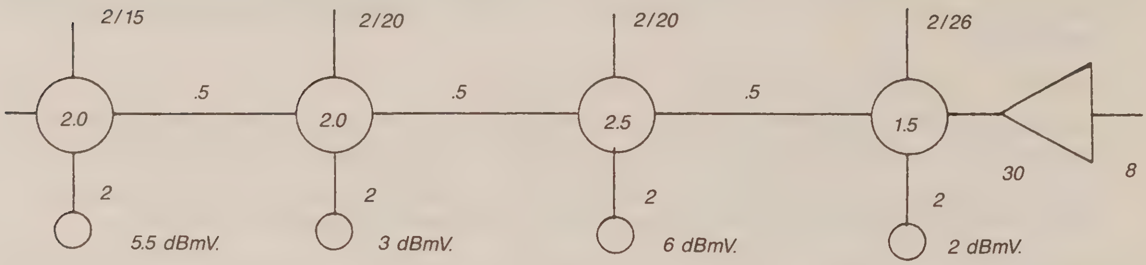
In many cases, a selection of the available range of values should be inserted into trial calculations which should be carried out to determine the best value in the range.

Once the best compromise component has been selected it should be included in the design.

As you progress along the distribution trunk, towards the main trunk, this selection procedure is repeated at each required tap location. Where two or more legs converge before the main trunk is reached, it will be required to combine the involved signal legs by utilizing either equal or unequal side loss components, i.e. a two way splitter SP1/3.5, SP1/8 or directional coupler e.g. DT1/10.

At any point along the distribution trunk, where the required drive level reaches 25-30 dBmV., an amplifier should be considered to restore available drive level. See *Fig. 2.H*

Fig 2.H



At the intersection between the distribution trunk and the main trunk, a further splitter or tap may be introduced to pick-off the required drive level from the main trunk.

As the cumulative process continues, a final drive level from the Head End will be determined.

If this required drive level is in excess of that which is available from the system processor, repeater amplifiers will be located along the main trunk to make up for any signal deficiencies.

This method of designing is employed widely in all States.

2.6.2. The United States Method/Cable TV.

The American Cable TV industry grew from the need to provide a more diverse menu of TV channels to many users in small towns, where the service was limited and to areas in such small towns, where physical obstructions, such as hills or high rise buildings, prevented TV reception.

A Head End was created adjacent to a high mast or tower, on which antennae were arranged to receive both local and as many distant stations as was possible.

Such signals, once processed to form a composite signal, were distributed around the town, utilizing in the main the overhead electrical supply pillars, to provide a support for the involved co-axial cables, amplifiers and drop taps.

As the overall aim was to supply every home in the town with this TV service, although this acceptance level was not often achieved, the end of the distribution trunk, or indeed the main trunk, was constantly being expanded or changed.

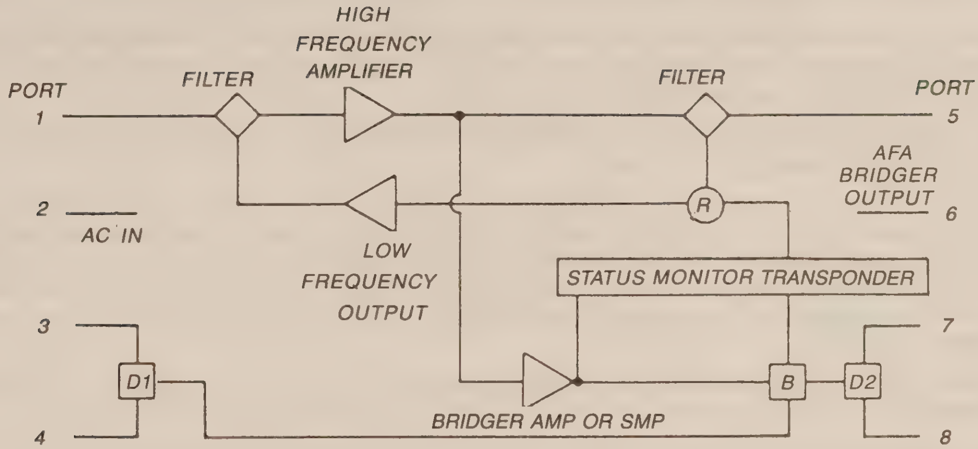
So, it was not possible to design from the furthest terminated tap back to the Head End, as with the European model previously outlined.

As, in many cases, long distances were to be covered between the Head End and the areas where distribution was required, a philosophy of Amplifier types was developed to cope with the distances and the outdoor location of much of the system's hardware.

Trunk amplifiers were designed to carry many channels and because they were of necessity cascaded many times, their output level was kept quite low, so the required output capability could be achieved without introducing unacceptable cross modulation and intermodulation to the signals in the system.

Such "Amplifier Stations" could also incorporate Trunk Taps, Splitters, Equalizers and the Bridger, or Distribution Trunk amplifier modules which were required to create further trunks of either type. See *Fig 2.I*

Fig 2.1



Distribution Amplifiers and or Line Extender Amplifiers were used in conjunction with a sequence of Line powered Drop Taps to complete the required distribution to each individual home which required service.

As with Cable TV systems elsewhere allowances were required to provide for drop taps at each housing location irrespective of whether the house was to be connected or not.

Calculations in essence are the same as for the previous design method discussed, but flow down the Head End in a descending manner, rather than from the extremities backwards.

When the THEN end of line tap location was reached, it was terminated with the use of a 75 ohm. resistive plug, irrespective of the involved tap side loss value.

These plugs were taken out as the system was expanded and once again the leg was terminated as required.

The drop taps were provided with "F" style connectors, which in turn handled the feeder into the adjacent home.

As the basic menu of TV channels was augmented by special PAY services, which could be called-up on demand, filters were incorporated into the drop taps to restrict services to a basic Tier. When the premium service was requested a service technician was sent to take out the trap which restricted service.

As systems and the involved electronic control methodology has advanced, such primitive ways have been dispensed with, to be replaced with microprocessor adjusted units having multi-layer functions and controls signals derived from a system polling computer terminal.

2.6.3. Low Rise Systems (Up to Four Levels).

Systems to service Low Rise buildings are in the main simple to design.

The task of obtaining suitable signals, of the required quality, from the antenna in such situations, is often more difficult.

The Head End should be located in a suitable, lockable, central postion.

As the total site is in most cases quite compact, the antennae may not be located in the same place, if this is not the preferred location either for technical or environmental reasons.

However, the interconnection with the Head End should be established using only low-loss co-axial cable.

Having calculated the system losses and the drive level required, an Amplifier will be selected which will provide for adequate levels to each system outlet. (+6.0 dBmV. UHF, 0 dBmV. VHF.).

Caution.

The system should never be driven at the maximum declared output of the amplifier in question. Signal level variations between night and day, can be in the order of 3 dB., so if the day level is utilized to produce the maximum rated output for a specific number of channels, any increase in the Off-Air level will drive the amplifier into overload.

This in turn will produce severe patterning due to the intermodulation products which are produced.

It is important when using Broadband amplifiers that the required Off-Air and In-House generated channels should be of the same level when they are introduced to this type of amplifier. Balancing may be performed by using Diplexers and series attenuators.

If this is not done the DOMINANT signal will dictate the performance of the amplifier and seriously inhibit the amplification of lower level channels.

Distribution components must always be located in an accessible place to allow for possible service, while the co-axial cable must never be cemented in or otherwise secured in a permanent manner. Where lift-up ceilings are available, as in the passage areas of many buildings, these provide the ideal location. Where cement blocks or poured floors provide no such convenient areas the cable should be run in conduit and the Splitters and Taps located in broom cupboards or on bathroom or kitchen walls, enclosed in a suitable housing.

Where aesthetic considerations are placed above expediency, it may be necessary to run the co-ax cable externally in conduit and to house the taps etc., in waterproof, outdoor housings.

In most Low-Rise projects, the floor plans of the ascending floors tend to be identical, so the use of a multi-port splitter to join the floor levels is often all that is required to provide for a good systems level balance.

2.6.4. High Rise.

The previous methodology for individual floor levels is still valid, however, several special considerations must be dealt with in multi-level situations.

The Head End is often halfway down the building so as to balance the available system drive level.

As the level of the involved floor gains in altitude, the system balance as called for in many current specifications, becomes a liability.

On lower levels where the building is in the "Shade" of another building and is thus shielded from the direct radiation of local TV transmitters, a system output level of 6 dB. or even 0 dB. may well produce a good clean picture, if this is available at the antenna.

Once the building "breaks clear", one or more sides of the building may be looking directly at the transmitter.

In these conditions the ambient signal in a room, may well be in excess of that provided via the TV distribution system. 20 millivolts of such an ambient signal are not uncommon even five or six floors up. So, it is a natural situation for the generation of a LEFT HAND GHOST, (see section 2.3.5).

Dependent upon the level disparity between the two sets of signals, the problem may be solved by local amplification of this part of the distribution system.

If this is not effective the only remaining solution is to Frequency Translate all affected Off-Air channels to new channel allocations. In this way the set's tuners provide for the required protection to prevent any form of picture degradation.

Such potential reception problems should be pointed out during the design phases of a project and action taken to negate them. The requirement to provide for an extra five sets of frequency translation equipment, comes as a great shock to the potential developer, if it is requested only during the commissioning phases of a project.

2.6.5. Outdoor (Caravan Parks, Marinas, etc.).

While the two previous sections have covered indoor situations, with the exception of some projects where limited outdoor involvement creates climatic problems, Caravan Parks, etc. are for the most part fully exposed to the elements.

It is expedient therefore to make use of the hardware used with outstanding success for many years in Amercia.

The solid drawn outer conductor of their co-axial cables, when coupled with the weather-proof Die-cast housings for Amplifiers and all distribution components, provides for the ideal equipment in these exposed locations.

While the Head-End will if possible be located in the reception area and while system calculations will be as for other systems, the method of distribution will be concentrated about "SERVICE PILLARS". Such pillars are available which house the TV Tap or taps, general purpose outlets and telephone jacks.

So, distribution cables often radiate in a series of arms from a central location to a sequence of pillars which may service four or more caravan sites.

Marinas employ similar pillars, but the system architecture tends towards the form of a series of legs attached to a common backbone, as with a comb. Low loss "FLYLEADS" are then provided with the Berth hire on a returnable basis for interconnection between the pillars and individual boats.

Section Three

INSTALLATION PRACTICE

3.1 Introduction

At the beginning of this Manual it was pointed out that the installation of a television antenna system should not be a haphazard affair.

It is important for an antenna system to be well arranged and properly protected and installed, otherwise sloppiness, poor connections and liability to damage can lead to losses at the high frequencies involved, with subsequent poor performance and lack of picture quality.

3.1.1. Requirements for a Good Installation.

A well installed antenna system results from:—

1. **A planned and organised approach to the job.**
2. **Use of the best component parts — quality/suitability.**
3. **Good workmanship.**

3.1.2. Organized Approach To The Job.

Although an installation does require good design and layout, together with the correct use of equipment and accessories, the work will be found to be straight forward and readily carried out, provided that it is well planned and organized. To achieve this we require:—

1 **A properly organized vehicle.**

2. **An adequate and well laid out tool kit.**
3. **A planned approach to the customer.**
4. **A clear plan for the job in hand.**

3.1.3. A Properly Oganized Vehicle.

A clean well looked after vehicle is its own indication of a careful workman.

Appropriate racks and shelves for the storage of tools and equipment, not only look much neater, but also make the job much quicker and easier.

The vehicle should not be cluttered up with unnecessary equipment and items which are not normally required, but should always be kept tidy with every thing in its place.

3.1.4. Suggested Vehicle Type.

The recommended type of vehicle for installation work is a panel van or combi-van. This should be fitted with a roof rack arrangement to carry the necessary ladders.

This rack should also incorporate a box in which masts can be carried and also for longer antennae. A perforated bottom will allow any rain to pass through.

The vehicle should be fitted out with appropriate shelves and bins to accommodate stocks of parts and with a readily accessible selection of tool boxes and tools.

The shelves can be easily fabricated from slotted angle strip and hardboard to suit you exact requirements.

It is suggested that stout cardboard, plastic or metal boxes of suitable size be obtained in which to store the smaller parts.

Naturally the position of stock items should be selected so that items which are in constant use are most readily accessible. Less often used items can be placed in less accessible corners.

A little thought and planning at the outset will be well repaid over a period of time, by both the ease of operation and the saving of time.

3.1.5. Ladders.

Two basic ladder types are required, an extension ladder for getting on to the roof and a step ladder for reaching the manhole and for other inside work.

A type known as a combination step-ladder is available which is very handy. As well as being used as a step ladder, it can be extended to form a straight ladder of almost twice its length. One of 2 metres reaches about 4 metres which will give access to most roofs. This can mean that only one ladder requires to be taken from the vehicle in many instances.

Of course, an extension ladder is still required and we suggest one of 4 metres, extending to 7.5 metres.

This should also give access to the roof of most two storey buildings.

3.1.6. Wood or Aluminium?

Opinions often differ about whether wood or aluminium ladders are to be preferred.

Aluminium ladders are lighter, do not absorb water, look better and normally can be expected to last longer, although they can be damaged by rough usage which wood will resist.

Attention should be drawn to the fact that the metal ladder will not be allowed by the involved unions on to many building sites, as it presents an electrical safety hazard.

Wooden ladders last reasonably well with care, but tend to give off splinters after some usage. They will withstand fairly hard handling, are much safer near electrical cables and can be considered to be reasonably good value for money.

If wooden ladders are employed they should be coated with linseed oil **NOT** with paint, as this oil will not obscure any defects which may occur, and allow for repairs to be carried out long before a breakage would occur.

Whichever type is used all ladders should be closely inspected at regular intervals to check that they are in good order and safe to use.

3.1.7. An Organized Tool Kit.

It is essential to have a good kit of the right tools and just as essential to understand how to use them correctly.

Most workmen have their individual preferences for particular tools, however the range will be basically the same in most cases.

It will be found convenient to group tools together according to their usage.

For instance, spanners and other tools for use on the rooftop or up a ladder should be kept in a convenient bag or pouch, which may be worn in a way which will leave the installer's hands free for climbing.

Tools required for drilling walls and making fixing inside the building, are best kept in a suitable tool box, so that everything necessary is on the spot when wanted.

This not only makes the job easier and more convenient, but it creates a better impression than many trips in and out of the building to collect individual items as they are required.

Screws, plugs and patching materials should also be in this tool box or in another small box which can be carried with it.

3.1.8. Tools Required.

All the normal contents of a tool kit will be required, such as a range of screwdrivers, pliers, diagonal cutters, wood chisels, cold chisels, centre punch, nail punches, hack saw, general purpose saw, claw hammer, small cross pein hammer, brace and set of wood bits, masons hammer, star drills, plugged chisel, set of twist drills, bradawl, knife, putty knife, multigrips, 10 metre extension cord.

One most important item of equipment is the electric drill.

This should be of the type which also converts to a hammer drill.

It is strongly recommended that it be double insulated for safety. One of adequate size and power and with a chuck capacity of 12.7 mm. should be chosen. A second battery operated self-charging unit should also be carried for convenience in areas where the larger unit would be cumbersome.

For drilling through brick and masonry walls long shank 30 cm length masonry drills of 16 mm and 6.3 mm size will be required.

Several sizes of normal length masonry drills to fit loxins, anchor bolts and plastic wall plugs will also be needed. Since these drills are used on abrasive materials they require frequent sharpening, so it is advisable to purchase several of each size.

For use on the nuts of the "U" bolts of antennae and for chimney kits, a set of tube spanners will be found to be most convenient.

If available, a ratchet spanner of the appropriate size, will certainly be appreciated when working at an awkward angle on a steep and slippery roof. For most other applications, such as tightening coach screws and loxins, a set of open ended/ring spanners will be most useful.

3.1.9. Approach to the Customer.

Customer relations can be the most difficult part of the job, but if approached with courtesy and understanding no insurmountable trouble should be encountered.

The reason for your being there is to provide the customer with a service and to give them satisfaction.

Carrying out the job neatly and efficiently and according to their wishes, should do just that.

You should remember two things, firstly that you are working in their domain among their possessions and secondly, they are really not sure about how capable and careful you are in you job.

As a result you will need to reassure them, both in your approach to the job and by your courteous approach and helpful advice and suggestions.

This will be greatly aided by your personal neatness and the tidiness and preparedness of your vehicle, tools and equipment.

You will need to discuss with them such points as receiver position, the desired antenna position, outlet type and location and where the cable should run. You should give advice where appropriate, pointing out any limitations but respecting the customer's wishes wherever possible.

3.1.10. Receiver Position.

The following points should be taken into account when considering the position of the receiver.

1. If possible it should be located within easy reach of a power point.
2. Avoid reflections from windows in daylight viewing.
3. Avoid direct light falling on the screen. Some background lighting may be necessary to prevent eye strain.
4. Avoid problems related to doorways, fireplaces and people passing in front of the screen.

3.1.11. Planning the job.

A great deal of time, and effort, can be wasted looking at the job and wondering just where to start. It can be even worse if you start at the wrong point and waste more effort.

Each individual job should be planned just as we plan the work for the day.

We know just what each job involves and it should take only a few minutes on the site to evaluate the situation and to plan the job in your mind, or if you find it best, on paper.

If the work has been planned and the tools and materials are organized and in the place where they are required, then the job can be carried out in an unhurried methodical manner with no waste of time or effort.

3.1.12. Cleanliness.

Among essential items of equipment should be a dustpan and brush and several drop cloths. These cloths should be about 2 metres square and should always be placed under the work area to catch any brick dust, plaster or other debris which may result from the involved work.

A clean one should also be kept for handling the man-hole cover, so that it will not be left with dirty finger marks.

Cleaning up must not be left to the customer, even if they offer to do it. **Your job includes the clean up.**

Care must be taken that the walls and ceilings are not marked by ladders or by dirty finger prints. If accidental dirt marks occur, they can usually be removed from most wall surfaces with a damp cloth sprinkled with a small quantity of Ajax, or any other similar cleanser.

Remember that good impressions left behind lead to recommendations to others by a satisfied customer.

3.1.13. Ladder Work.

When carrying metal ladders care must be taken that they do not break a lamp and make contact with the element which can be live.

A ladder should not be placed where it's feet will damage a prized section of garden and care must be taken to avoid damage to the gutter against which it leans.

Limbs of trees or shrubs should not be broken off or bent back to make way for the ladder.

When working on a metal, or fibre panel roof, it is important to avoid causing damage by walking only where the rows of nails indicate that there is a timber beam underneath. On a tiled roof, only the "nose" of the tiles should be trodden on.

There should be no need to remind you that only rubber soled shoes should be worn when working on a roof.

Any holes which are drilled in error, or plaster which is cracked from drilling, should be made good with the appropriate patching material.

Where the cable passes through a metal flashing, it is best weather-proofed by the use of an epoxy type patching material, which is quick drying and long lasting.

3.1.14. General Installation Methods.

The work done on the installation of a system falls into three general categories.

1. Fixings — of brackets, antennae and accessories.
2. Running cable.
3. Making connections between the cable and the items which we have fixed.

First we will look at connections and how they should be made so that when we come to the installation of antennae and outlets we will already understand how to connect them.

3.2. General Notes on Connections to Co-axial Cable.

Co-axial cable for use in domestic installations has been designed for low cost and ease of handling. It needs to have a reasonably low through loss and adequate shielding properties.

Two basic types are employed.

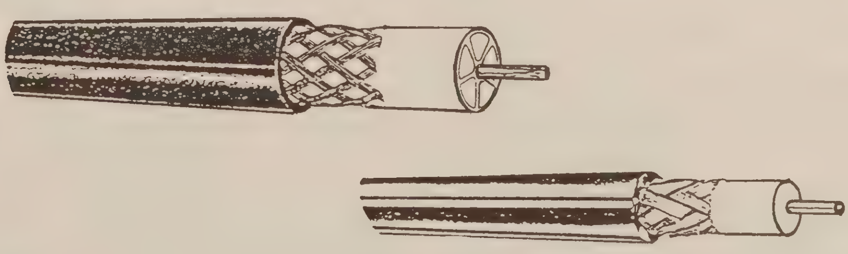
One, having a FOAM dielectric, while the other employs the semi-airspaced medium which is popular in Europe.

Both types have a screen derived from braided copper wire. This is then covered by an extruded plastic jacket.

The inner conductor may be of annealed copper wire, or copper steel wire.

it is important when making connections, that good contact is made to the braid and the inner conductor and that the cable is not malformed in any way. Squashed or bent cable will result in "Frequency Dropouts", which will give unpredictable results. Care should be taken to prevent any stray stands of the braid from making contact with the inner conductor. See *Fig 3.A.*

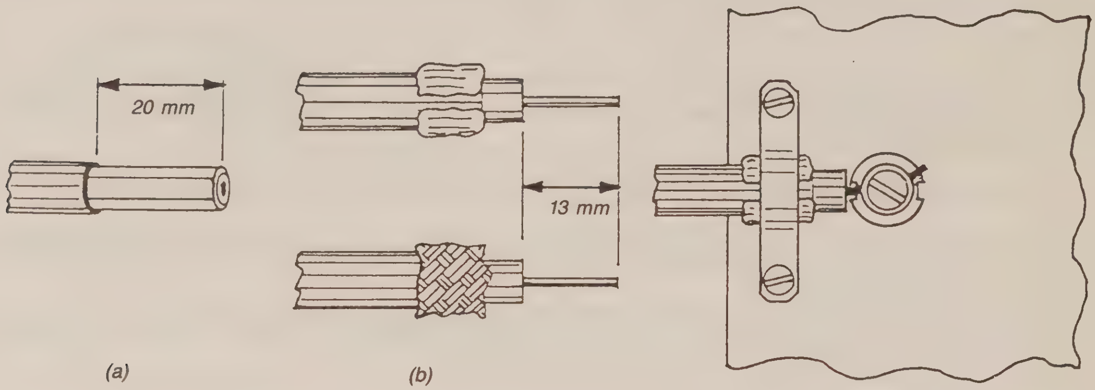
Fig 3.A.



3.2.1. Saddle and Screw Type Connections.

These type of connections can be found on some forms of Splitter, Tee unit, Outlet or Antenna. See *Fig 3.B.*

Fig 3.B.



The fitting steps are as follows:—

1. Remove the outer covering for a distance of 20 mm being careful not to damage the outer conductor.
2. Carefully flare out the braid and turn it back over the outer covering.
3. Remove 13 mm of the dielectric from the centre conductor and the cable should then look like Item (b).
4. Back out the two saddle screws and the centre terminal screw and insert the prepared end of the cable under the saddle. See that the centre conductor goes underneath the washer and on the correct side of the centre terminal screw, which is offset for the purpose.

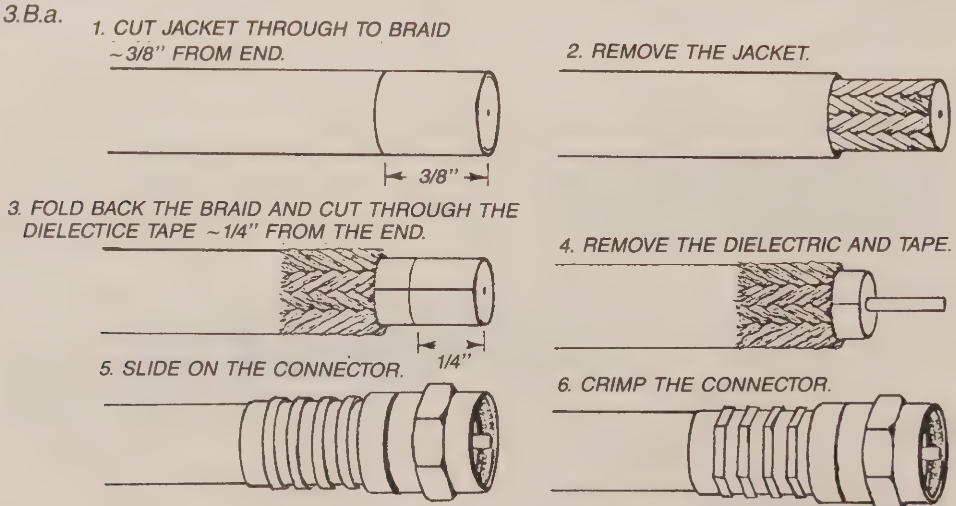
   It is not necesarry to bend the end of the conductor around the screw. Take care that the loose stands of the outer conductor do not cause any short.
5. Tighten the centre terminal screw onto the conductor. Carefully tighten the two saddle screws alternately, so that the cable is securely held but is not flattened. Any ends of braid can be trimmed off, or folded back over the edge of the saddle.

3.2.2. "F" Type Connectors.

These connectors can be found in use on some types of Splitter, Tee Unit and associated products. They can be obtained with several different sleeve dimensions to allow for their use with several sizes of co-axial cable.

Being derived from American MATV sources they are best used in association with a cable which employs a steel centre conductor. See *Fig 3.B.a.*

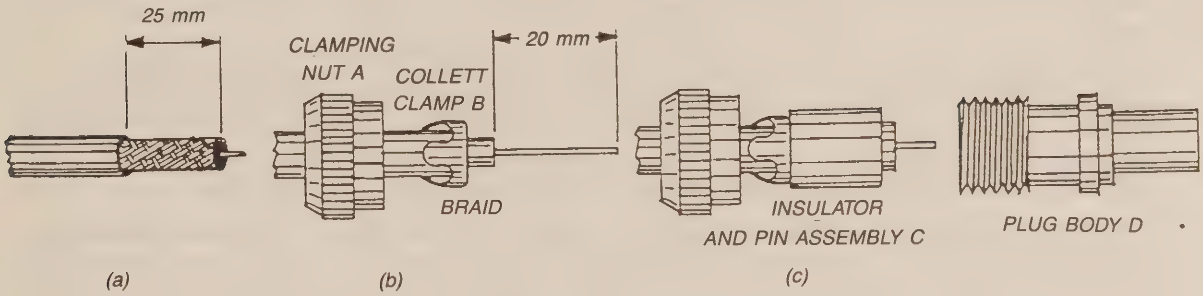
Fig 3.B.a.



3.2.3. Belling Lee Connectors.

The Belling Lee Type TVP3 plug and its equivalents, use a "tulip type collett clamp which is shown in *Fig 3.C.*

Fig 3.C



The fitting procedure is as follows:—

1. Slide the clamp nut A over the outer covering of the cable, making sure it is facing in the correct direction, push it back out of the way.
2. Remove the outer covering for a distance of 25 mm as shown at (a) being careful not to damage the outer conductor.
3. Push to collett clamp B over the braid and against the outer covering. Flare the braid and push it back over the collett clamp, trimming it so that 6 mm protrudes over the shoulder of the clamp.
4. Remove the dielectric from the centre conductor for a length of 20 mm and the prepared cable should look like (b).
5. Remove the insulator and pin assembly C from the plug body and fit it on to the centre conductor making sure it is pushed up hard against the braid and collett clamp. Trim off more dielectric if necessary.
6. Heat the tip of the protruding centre conductor and apply resin cored solder. When the solder flows onto the centre pin and adheres to the end, remove the heat and allow it to cool. Do not over heat or the polythene insulator will melt. With cutters trim off the excess length of the centre conductor past the end of the pin.

   Note. In many versions of this plug, the solder connection has been replaced with a set screw. Follow the steps up to 6, at this point unscrew the set screw enough to allow the inner conductor to pass freely through the insulator. Tighten the set screw until it makes firm contact with the inner conductor. Do not over tighten. Cut off any excess inner conductor as before.
7. Fit the plug body D over the insulator and pin assembly, slide the clamping nut up to it, making sure the threads mate correctly and are not cross threaded. Screw the nut up tight on the plug body.

3.3 Running the Cable.

Safety

When arranging cable runs always consider the possible position of the electrical wiring.

Electrical cables with only rubber or plastic protective sheathing may be hidden away in cavity walls, under floors, or embedded in plaster or cement rendered walls.

The possibility of a faulty earth connection at the power outlet cannot be disregarded and if a drill with a metal body should make connection with the electrical conductor by piercing the sheath, a very dangerous situation can arise.

For this reason a double insulated type Electric drill should be used wherever possible. Even then, remember that the metal drill bit and the chuck can be "alive" if a cable has been pierced.

Even if all precautions are taken for personal safety, take care to avoid breaking into cables. The costs involved to replace the cable, replastering etc. and the disruption to the customer's supply, will not make you "The Flavour of the Month".

3.3.1. Main Considerations.

The important considerations to take into account when running the cable should be as follows:—

1. **Neat** and **Inconspicuous**

Always use any concealed routes which may be available in a building such as ceiling spaces, wall cavities and under floor spaces. Check if any conduit has been provided under the plaster for the TV cables.

Only use surface runs when suitable concealed runs are not available. Remember that sometimes the cable can be run inside a "built in cupboard" in one room and then throught the wall to the required position.

2. Protected from **Damage** and **Disturbance.**

Cables should always be run where mechanical damage from furniture and passing traffic is least likely to occur. Even in ceilings if the cable is in an area subject to heavy traffic it should be protected in conduit where necessary. Make sure that co-axial cable is not subjected to heat and avoid proximity to the hot water pipes in ceilings and cavity walls. Constantly damp areas should be avoided.

3. **Economical** both as to length of cable and the time taken to run it.

Where ever possible the cable route selected should be not only the most suitable, but also the most economical in the length of cable to be used and in the required installation time.

Sometimes the extra time involved in trying to make a run short, is not worthwhile and sometimes the easy way out means the use of excessive lengths of cable.

Compromise and a realistic appraisal of the situation should lead to the best overall economy.

3.3.2. Types of Cable Run.

The types of cable run commonly encountered may be classed as:—

1. CAVITY

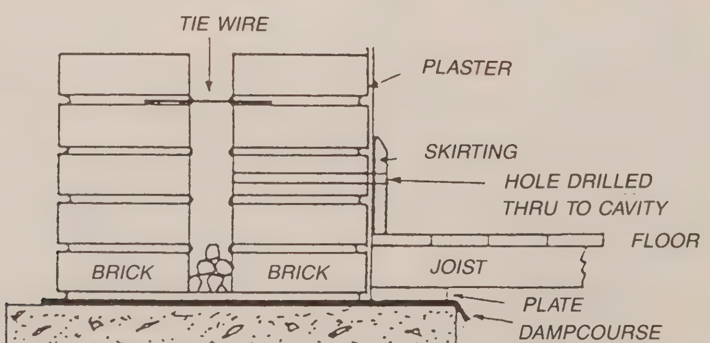
Cable which is installed in the wall cavity is fully concealed and protected and is in most cases the quickest and most easy to run. For these reasons it should be the preferred method of installation where ever possible.

The only operation which gives some installers trouble and uses excessive time and effort is the locating and drawing through of the draw cord and attached cable.

This will be dealt with in some detail, because when understood and handled correctly this operation should be simple and quick.

It is first necessary to get some idea in our mind of just what is behind that hard blank wall when no way exists to see just what is taking place. *Fig 3.D.* is a cross section view of the bottom section of a typical brick cavity wall.

Fig 3.D.



Note that a hole drilled through the skirting as shown will be in the vicinity of 10 to 15 cm above the bottom of the cavity.

Often a lot of mortar has been dropped in the cavity in the process of building and this can vary the depth considerably. The hole drilled should be 16 mm in diameter and this gives very little scope for finding a single strand of cord, hanging vertically. Therefore a planned method of retrieval should be used.

The recommended method makes use of two simple items.

One a strong thin cord, commonly known as "Builders Line" and second, the right type of hook.

The cord has a breaking strain of about 350 Newtons. Essentially it is smooth and flexible so that it will readily slide down the rough uneven surface of a wall cavity.

At one end it should have several small pieces of sheet lead clipped round it. Remember to keep them very small since they have to be able to be pulled through the 16 mm hole.

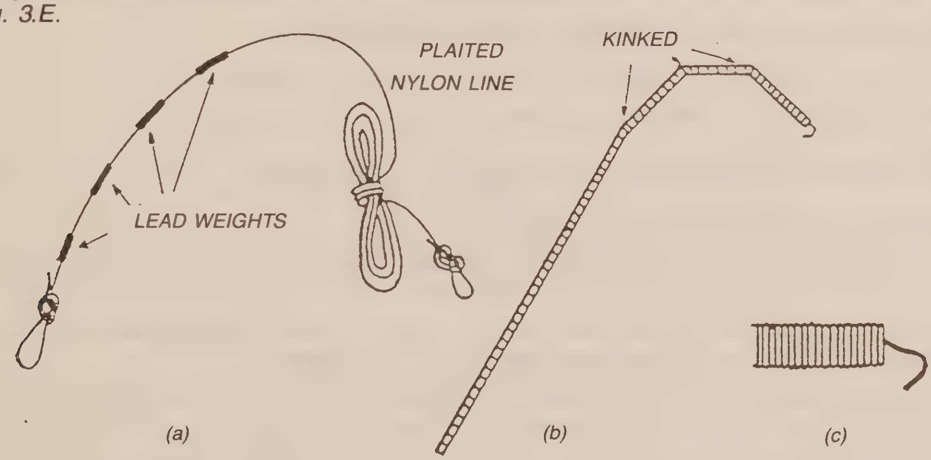
Sufficient weight should be used so that when the cord is lowered down the cavity, you can feel it hit the bottom.

The line should have a length of about 6 metres.

The hook can be made from a section of the outer casing of a "Bowden" cable. Such cables were used before electronic instrumentation was adopted for speed recording in motor cars.

Most wreckers yards should be able to oblige. Preferably with a diameter of about 5 mm and about 1 metre in length. At one end this should be given a slight kink in three places about 50 mm apart as shown in *Fig. 3.E.*

Fig 3.E.



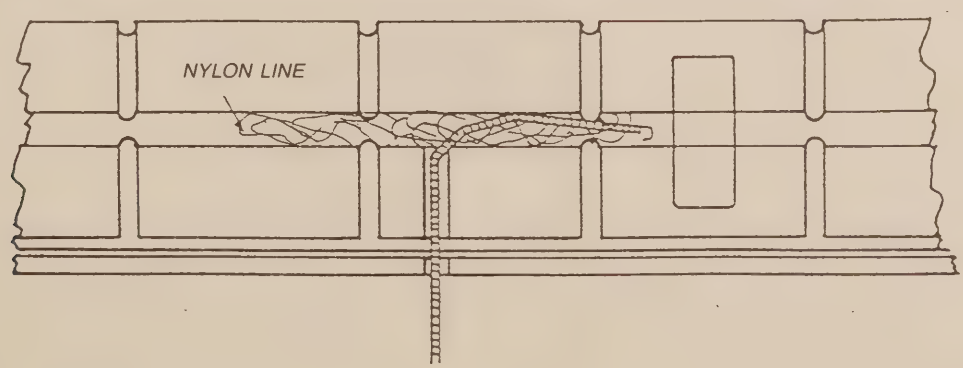
At this same end, the end of the spiral should be separated and bent to form a small hook.

It is most important to keep this hook small enough so that it cannot catch over the tie wires in the cavity, in fact just open enough to readily catch the line is the best size to have . . . See detail (c).

After the hole has been drilled through the wall into the cavity, the cord is lowered into the cavity, as directly above the hole as can be estimated and after the lead weights have been felt to reach the bottom at least 2 to 3 metres of the cord will be allowed to slide down gradually into the cavity.

If properly handled this extra cord will drape itself backwards and forwards on the bottom of the cavity, see *Fig 3.F.*

Fig 3.F



About 40 cm of the hook is then pushed into the cavity and given one complete twist in the direction in which the open hook on the end faces. Gently withdraw the hook. At least one loop of the cord should be caught up in it. If not repeat the process, this time so that the hook is pushed along the cavity in the opposite direction. Give one complete twist and then withdraw.

Do not be tempted to give several twists because a knot of cord too big to pass through the hole may result, ruining both the hook and the cord.

Once the cord has been located, it is relatively easy to draw through the co-axial cable.

The co-axial cable may be either drawn up the cavity, from down below, or drawn down from up above.

Drawing the cable down is the preferable option, as then only the required length of coax will be drawn past the sharp bend where the hole meets with the cavity. If drawn up, the whole length is pulled through the hole and great care and not a little time must be taken so as not to stretch the cable or to damage it in any way.

2. SURFACE.

The running of co-axial cable on the wall surface means that extra care must be taken to keep it neat and tidy.

Also we have to maintain that it will be suitably protected from damage from furniture or passing traffic.

Before making a start, the most suitable run must be selected. This should take into account the following considerations:—

1. **The cable should be camouflaged wherever possible.**
2. **It should be protected from both heat and mechanical damage.**
3. **The run selected should be economical of both cable and time.**

Cable should be run horizontally or vertically, but in a straight line.

For horizontal runs use picture rails and skirtings.

The aim is to follow existing lines and to avoid creating new ones in the room. It is also simpler to make use of wooden surfaces in preference to others, skirtings and door frames are a prime example.

The cable fixings should hold the cable securely but they must not in any way damage the cable. In particular they should not pierce the cable or make a dent in it.

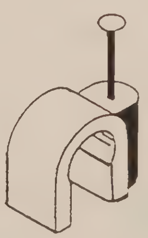
Remember that the cable manufacturer went to great lengths to prevent such defects during manufacture, as the RLR of the cable would be dramatically affected.

Staples placed at regular intervals and causing squashing of the cable each time will have the same effect.

The preferred fixing see *Fig 3.G* is provided by a plastic cable clip. These clips come in various sizes to hold a range of different cable types. Make sure that you use the correct size for the cable in question.

The plastic clip consists of a saddle of moulded plastic which contains a steel pin. This pin is hardened so that it may be driven into mortar courses and plastered surfaces.

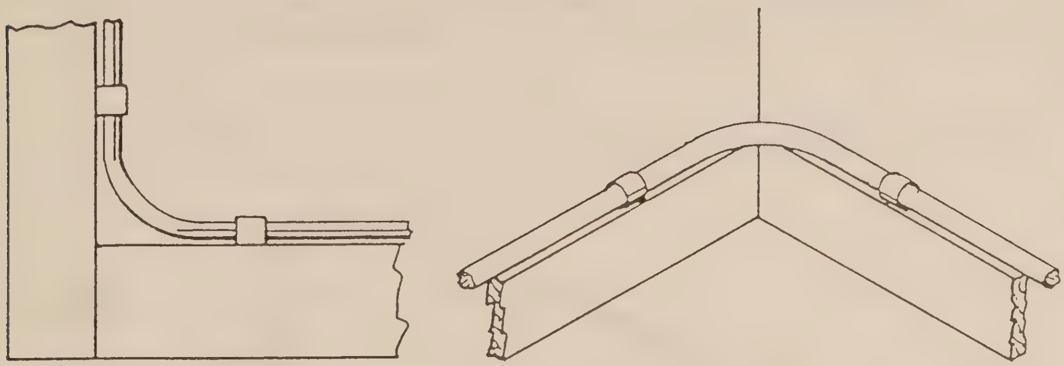
Fig 3.G



Where changes of direction are required on the co-axial cable run, care must be taken to see that the cable is not bent at a sharper angle than that recommended by the manufacturer. The minimum bending radius of a co-axial cable is not less than eight times the diameter of the cable in question.

When cable is run down a door-frame and turns to pass along the skirting, clips should be placed before and after the bend, but never in the middle of the bend, as the cable may be damaged. See *Fig 3.H.*

Fig 3.H



3. CEILINGS.

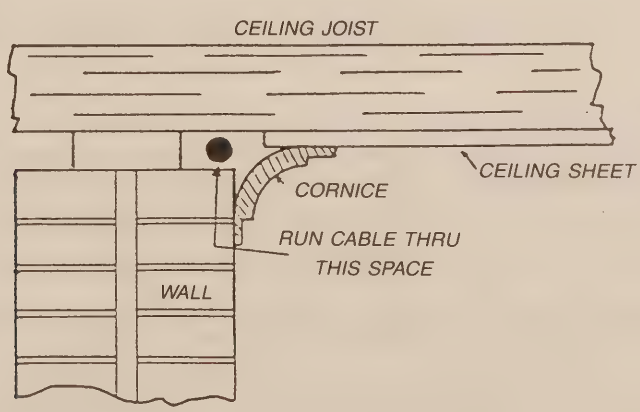
The ceiling space is convenient and easy for running of cables. However, remember that the householder and tradespeople may later walk or crawl through the area.

It is often cramped and in most cases quite dark so we must make sure that our cables cannot be tripped over or trodden on. To this end they should not be draped around loosely, nor must they lie on the top of joists.

Where it is unlikely to be disturbed the cable should be secured to the side of beams or joists by the use of plastic clips. Where subject to traffic the cable should be protected by conduit. This need not be continuous, but composed of short sections which are secured to the beams.

As shown in *Fig 3.I.* often a gap exists along a cornice, or on the top of a wall, through which cable can be quickly run without the need for fastening. Make sure it cannot be damaged by being trodden on.

Fig 3.I



4. OUTSIDE.

When running cable outside, remember that plastic breaks down when subjected to UV radiation. Only cable with a specially treated black plastic sheath to combat UV should be used.

Outside surface runs are substantially the same as those indoors, but they may be more subject to damage, so steps should be taken to protect them where necessary.

Co-axial cable should never be draped across a roof. It if has to run over a roof outside, then suitable conduit should be provided, which is first firmly fixed to it.

The cable from an antenna is best brought down inside the masting itself, or if this is not possible, then it should be firmly strapped to the masting with black plastic ties. See *Fig 3.J.*

Fig. 3.J.

5. CATENARY.

Where cable has to be run between two existing buildings, unless underground conduits already exist, the most economical method is to use overhead or catenary wiring.

This consists of a supporting wire to which the cable is securely strapped. In most cases this wire has a turnbuckle at one end, so that the wire may be stressed. The cable should be taped to the wire with electricians tape and then over-strapped using black plastic straps or cable ties.

Be sure the fixtures to hold the supporting wire at each end are adequately secured. Allow a large drip loop in the cable at each end, not only to prevent the ingress of water, but also to isolate the co-axial cable for any strain.

The simplest method of working is to secure one end to the wire and then, while still on the ground, strap the cable to the wire progressively until the other end is reached. It should then be hooked to its fixture.

6. CONDUIT AND DUCTING.

Since co-axial cable must not be embedded in plaster or cement, it sometimes becomes necessary to install conduit in such materials, together with a draw wire, for later installation of the cable.

Elbows must not be used for co-axial cable, only bends are considered to have sufficient radius.

Co-axial cable should never be drawn round more than two bends in any conduit run.

When drawing through conduit the draw wire should be secured to both the inner and outer conductor of the cable. Draw the cable in with a steady pull, free from any jerks.

Where cable requires protection on surface runs, it will often be found quicker and easier to install plastic duct instead of conduit. This can be fitted either before or after the cable is run.

General Comments on Running Co-axial Cable.

Co-axial cable must not be embedded in plaster, mortar, cement, or any similar material. It must not be run in cracks or joints in walls.

All cables installed ouside of buildings must posses a black plastic sheath. Where cable is brought through walls from outside a building, it must be installed with drip loops.

Nail rings or staples must not be employed with co-axial cable.

Kinks and sharp bends must be avoided and cable runs must not be provided where the cable may be subject to indentations or other damage. Particular care should be taken with cable installed on building sites during the course of the building.

3.4. Installation Fixings and Mountings.

From the antenna through to the outlet, the appearance and durability of the installation depends upon the proper fixing of any item. A neat appearance is important, not only because it looks pleasing, but also because it idicates that care has been taken with the work.

Continued satisfactory operation of the installation can be dependent upon the correct fixing of all component parts.

Fixing should not only be adequate, they should also be appropriate. The correct type for a particular application should be used.

An installer needs to be familiar with a wide range of fixings and to understand their varied applications.

Fixings that we are concerned with will be those used for fixing the following groups of products.

ANTENNAE MOUNTINGS
— CABLES — OUTLETS — SPLITTERS/TEES ETC.

3.4.1. ANTENNA.

The location of an antenna and its mountings with respect to telephone and power lines is important. An antenna must be kept well clear of any such lines and the feed-in cable should not run above or below them.

A guide as to the clearance distance required is, if the antenna falls over will it fall well clear of the lines, or, if the line falls, will it fall well clear of the antenna?

Where an antenna is mounted on a mast with a free length or more than 3 metres, the mast must be guyed unless it is of the self-supporting type.

Antennae must not be mounted on sheet-metal or weak structures.

Installers should make sure that they are aware of any regulations made by the local authority, which apply to antenna installation.

The following forms of antenna mounting will be dealt with.

3.4.2. CHIMNEY MOUNTINGS.

Before attempting to use a chimney for mounting an antenna the chimney should be checked to ensure that it is strong enough.

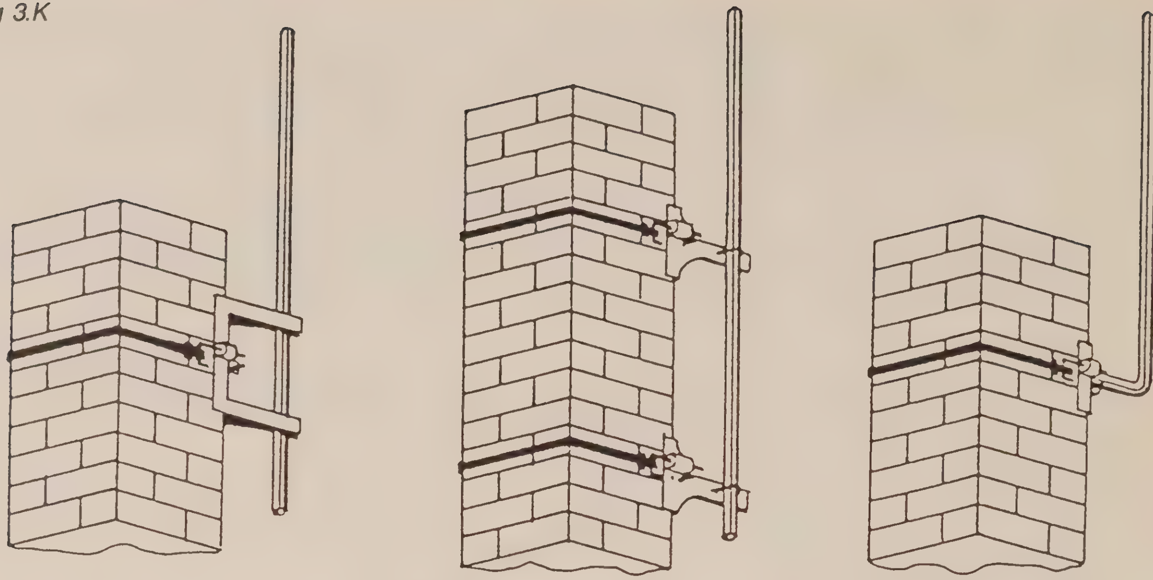
The mortar should be firm and not crumbling and the brickwork should be free from cracks with no sign of fretting.

The chimney bracket should be mounted as low as is possible on the chimney to provide an adequate margin of safety.

In any case the top lashing should not be mounted higher than the fourth course of bricks from the top of the chimney.

Where the free length of the masting exceeds 2 metres, double lashing must be used. The free length of mast must not extend more than 3 metres above the last point of attachment. See *Fig 3.K* which shows the single and double lashing types and also the curved chimney bracket which is suitable where only a short chimney is available, or where a light UHF antenna is to be installed.

Fig 3.K



3.4.2.1. WIRE LASHING.

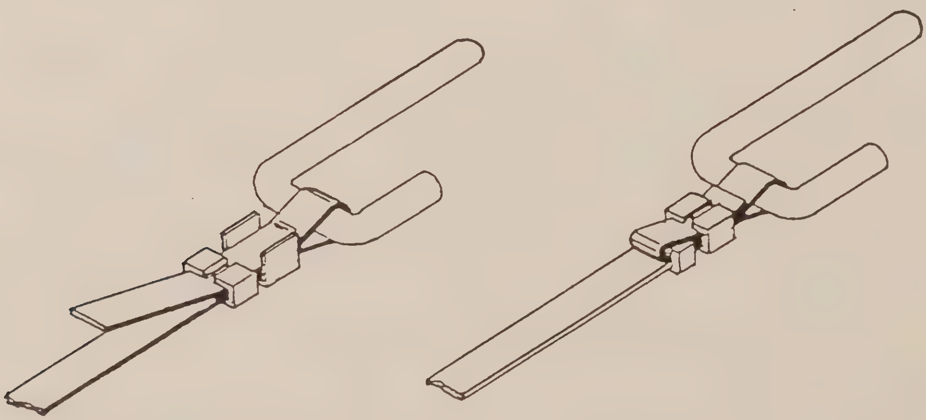
Where wire lashing is used, corner guards must be provided to protect both the wire and the brickwork.

The wire must be protected by thimbles where it passes around "J" bolts and suitable wire clamps should be used to securely fasten the wire. Galvanized guy wire should be used for all such lashings.

3.4.2.2. STRAPPING.

Galvanized steel, or stainless steel strapping of 20 mm width should be used with the correct strapping seals. See *Fig 3.L* for an illustration.

Fig. 3.L



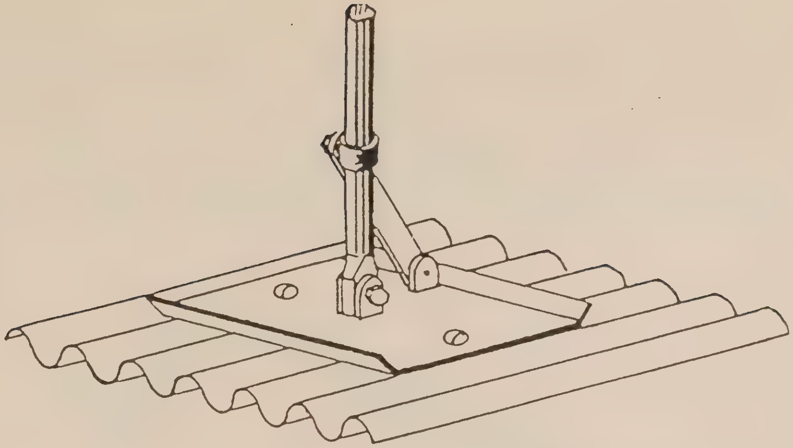
3.4.3. ROOF MOUNTING.

Since most roof mountings inevitably involve piercing of the metal sheeting, care must be taken to prevent the ingress of water. Wherever possible, holes should only be made in the tops of flutes.

In any other case it is essential that the holes be sealed with a suitable mastic material to prevent any leaks.

For use with corrugated iron or aluminium and vee crimp type sheeting, the adjustable roof mount (See *Fig 3.M.)* will be found to be suitable. As the name implies, it can be adjusted to suit the pitch of the roof. It is fixed by two coach screws through holes spaced to fit on the top of the flutes and slotted to allow for adjustment.

Fig 3.M.

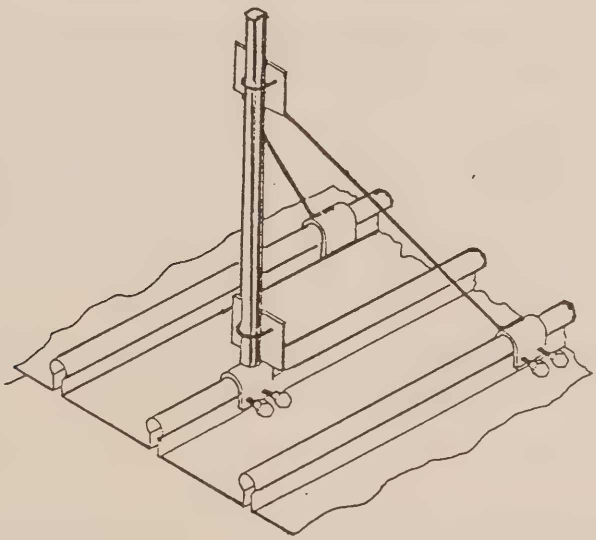


3.4.4. STEEL DECKING.

A special mount is made to fit the requirements of steel decking. The mount is arranged to clamp securely to the ribs of the profile by means of set screws.

All brands of metal roof decking are served by this single unit. See *Fig 3.N.*

Fig 3.N.



3.4.5 GUYED RIDGE MOUNTING.

Where no chimney is available but more height is required, a 4 metre or even 5 metre mast can be mounted on a ridge mount and guyed with a set of triangular guys.

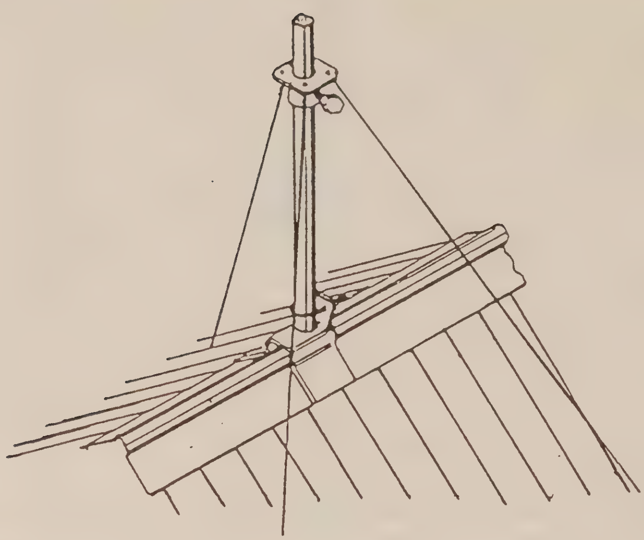
The ridge mount should be fixed by means of 75 mm coach screws secured into the ridge timbers.

The guy anchor points must be spaced at 120 degrees to each other and must be a sufficient distance from the mast for the guys to subtend an angle of 60 degrees from the horizontal.

The correct size support tube assembly and guy plate should be fitted in the three holes to be used. 7/18 galvanized guy wire is then threaded through the thimbles and held with wire rope grips. For the guy anchors 75 mm screw eyes are fixed through the top of the flute into the roof timbers and the guy wires are again passed around thimbles and held with clamps.

On a small installation such as this, turnbuckles are not required, since the guywire lengths can be readily adjusted and sufficient tension obtained by hand. See *Fig 3.0.*

Fig 3.0.



3.4.6. WALL MOUNTINGS.

Wall type antenna mountings are concerned with two types of material.

1. Brick/Masonry Walls

2. Weather-boards/Hardiplank Walls

Double brick cavity walls and double brick solid walls, if they are in good condition, provide a satisfactory means of mounting brackets for antennae. Single brick walls, as with brick veneer, may be satisfactory, but single brick gables should be treated with care as they often will not produce the required support.

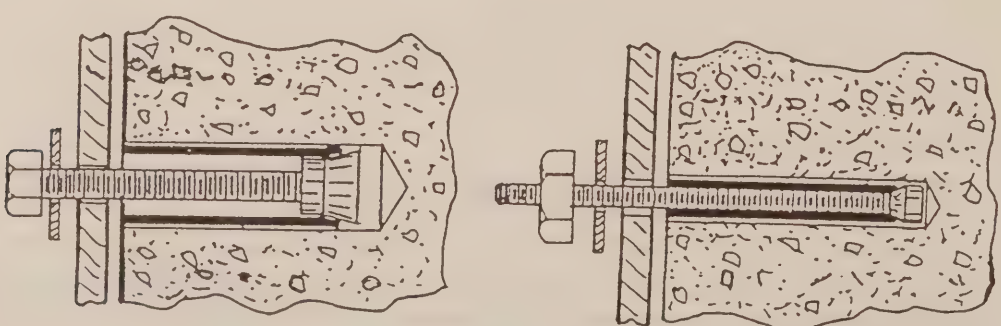
The top mounting hole of any bracket must be at least 30 cm from the top of the wall. When more than one bracket is used they should be at least 30 cm apart. Each bracket should be securely fastened to two bricks and should be fastened to the brick, not to the mortar in between.

Explosive charge fixings are not considered suitable for fixing brackets to the walls of domestic buildings.

Mounting bolts used should be of the expansion type, designed to be used with masonry. Two basic types of these are the loose bolt type and the projecting bolt type.

The loose bolt type, of which the Loxin (R) and the Rawlbolt (R) are typical examples, have an expansion shell which fits flush with the surface and into which a bolt screws as shown in *Fig 3.P.* On timber framed structures brackets should be fixed to the framing, or stud walls.

Fig 3.P.



If this is not possible timber of a suitable size should be fastened to the studs and the brackets then secured to the timber.

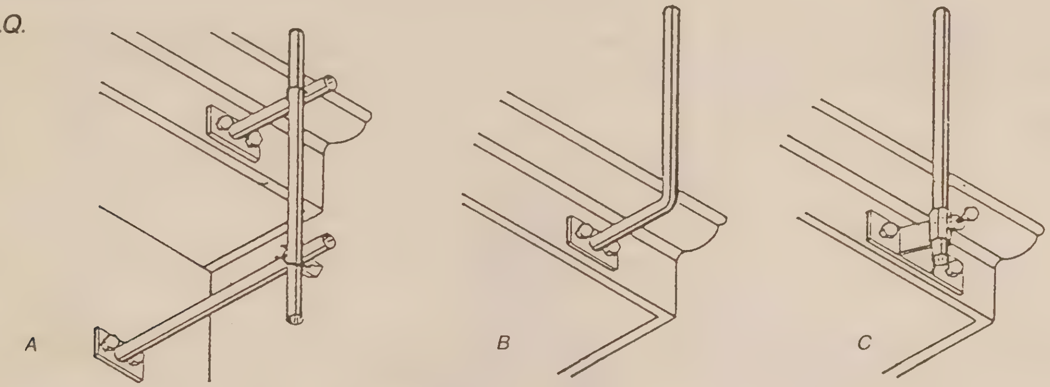
Coach screws of adequate length should be used to fix the brackets. A hole of sufficient diameter to provide a tight fit for the shaft of the screw should be drilled first to avoid splitting the timber. Where

it is possible to use bolts and nuts with a suitable backing plate this will provide a more secure fixing. Coach screws are not suitable for fixing into the end grain of timber.

The base of the mast should always be extended at least 60 cm below the roof line with a bracket as near the roof line as possible and another bracket at the bottom of the mast.

Brackets mounted on fascias serve two different purposes. An eave bracket is the top fixing for a mast supported below by a wall bracket as shown in *Fig 3.Q.*

Fig 3.Q.



The other case is the self contained curved fascia bracket which has its own curved mast for the antenna as shown (b) above. Another type is the fascia mount bracket (c) which uses a 25mm mast gripped by a set screw. This allows ready adjustment of the antenna height, useful in difficult areas.

All of these brackets can be held on the fascia with coach screws of the appropriate size. It is important to ensure that the fascia is wide enough, is of solid timber of adequate thickness and is securely fastened to the rafters.

Wherever possible bolts with a backing plate should be used for more secure fixing.

Modern type sheet metal fascias require the services of a special mounting bracket which bolts to any adjacent roof truss. Holes drilled in the fascia to locate with the mounting bracket may be secured with the use of a galvanized nut bolt and washer.

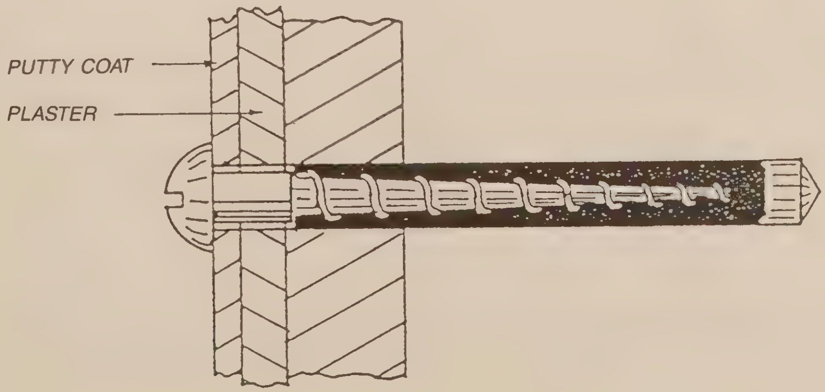
Outlets have to be fixed to either bricks/masonry/bare plaster, or sheet linings such as hardboard, fibre or gyprock.

Ideally outlets should be housed in a wall box cemented into the brick wall to provide a neat flush fitting. However, this may not be desirable or indeed possible, in an established home. The alternative is to fit a plastic box to the wall, onto which the outlet plate can be mounted.

Such small fixings in brick can be conveniently made with plastic wall plugs. These come in a pack which indicates the required drill size to complement each type.

The length of the plug and of the fixing screw are both very important as can be seen in *Fig 3.R.* It must be remembered that the wall usually consists of a putty coat and plaster on top of the brick surface. This can be as much as 13 mm thick.

Fig. 3.R.

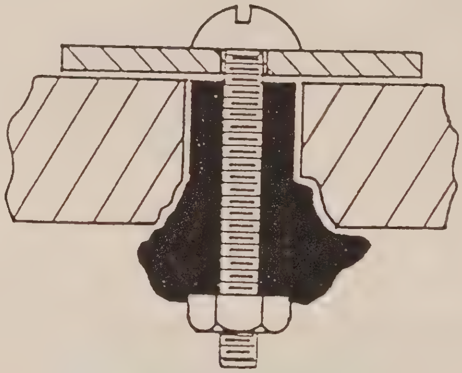


If only a short plug and screw are used, when the screw is driven in it expands the plug, the plaster will break away and a loose fixing will result. For this reason it it important to use a plastic plug at least 40 mm long in a plastered wall. Where a bare brick wall is to be fixed to, at least 25 mm plugs should be used. When a fixing is made through a thin article, the end of the plastic plug should be sunk into the hole to a depth which will avoid the un-threaded shank of the screw being driven into it.

Hollow masonry blocks, such as Besser blocks, have a wall thickness of 10 to 13 mm and are not suitable for plastic plug fixing. When the hole is drilled it will "star-out" when the drill breaks through into the inside of the cavity.

The recommended type of fixings are Rawlnuts as in *Fig 3.S.* Type 316 should be suitable for fixing outlets, or for plastic blocks for outlets.

Fig 3.S.

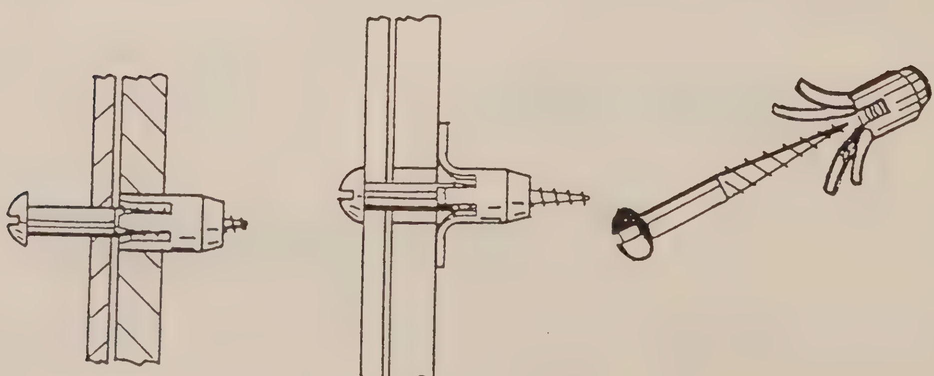


Fixings must never be made into the mortar courses between bricks.

In all brick or masonry wall fixings it is necessary to use a carbide tipped masonry bit of the size specified for the fixing to be used. It is most important when drilling masonry to keep adequate pressure applied to the drill bit to keep it penetrating material. If it is allowed to rotate with only light pressure, the abrasive nature of masonry will quickly blunt the drill bit and cause overheating.

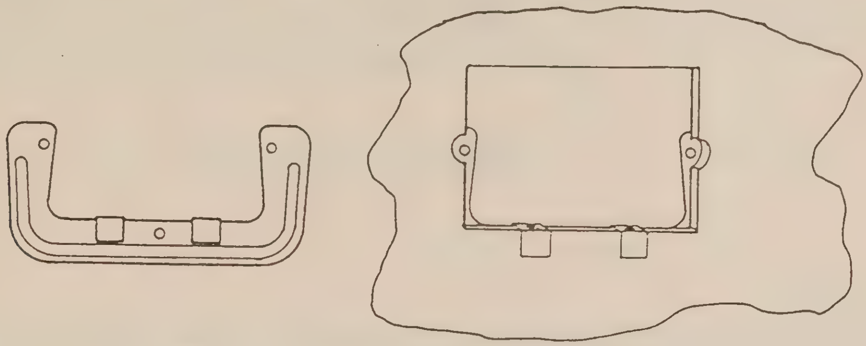
Where outlets have to be fixed to hardboard, fibrous plaster or gyprock several methods are available. In many cases Rawlnuts, as shown previously, will be suitable. A cheaper method is to employ an anchor style plastic plug see *Fig. 3.T.* This is available in several brand types which are all very similar. The size of hole specified on the box is drilled in the material and the plug is then fitted as shown.

Fig 3.T.



Where a hole has to be cut out for outlets such as Hills U01, and the fixing holes are near the edge this can cause difficulties with soft materials such as gyprock or fibrous plaster. Electrical mounting brackets are intended for just this situation and one is shown in *Fig. 3.U.* together with its method of fixing. This is a very simple but effective method for mounting these units.

Fig. 3.U.



Where Splitters and Tee units are to be mounted on the wall surface, either plastic plugs in brick, or anchor plugs in wall sheeting should be used as appropriate. It is normally satisfactory to mount these units with two diagonally opposed holes. Where timber is available then this can be achieved with wood screws. Splitters and Tees used in ceiling spaces should be fastened to the side of hangers or joists with two wood-screws to keep them safe from damage.

3.5 Fringe Area Installations.

For any antenna to perform effectively, it should be placed well above the ground and clear of any obstruction which will shield it from the reception of TV signals.

When the antenna is located a considerable distance from the required TV station, this becomes even more important.

Since the signals will be weak and probably scattered, an efficient antenna system will be required to provide for the maximum pick-up of the available signals.

So, it is common to make use of Telo-masts, Winch-up masts, or even large Butt Section masts, in the search for a signal of optimum strength.

In its turn this leads to the use of extended cable runs, in order to connect the antenna array to the TV receiver. The involved losses are considerable.

So, to overcome this loss, a Mast Head Amplifier, or Pre-amplifier, is employed.

The typical fringe area installation therefore often consists of a large antenna, or combination of antennae, with mast head "Booster", mounted at the top of a high mast.

Let us examine these areas, commencing with the Amplifier.

3.5.1. Mast Head Amplifiers.

This form of amplifier should have the lowest Noise Figure possible. As this amplifier, while boosting the weak signal also amplifies any noise which the antennae may pick up. So the signal to noise ratio is at its minimum at this point.

Any amplifier will add noise to the system, due to the involved electronic components and such noise figures vary over a fairly wide range. By careful choice of transistors and PC board design, it is possible to produce mast head versions with a noise figure of about 2 dB.

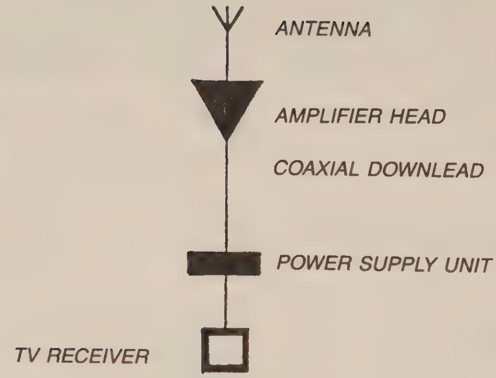
The amplifier should have sufficient gain to overcome the attenuation of the down lead and built in protection against static build up and lightning strikes.

Because they are sometimes used in proximity to regional stations, they require to handle relatively high input levels without overloading.

3.5.1.1. Hills Range of Mast-Head Amplifiers.

Hills manufacture several types of mast head amplifiers. These cover the range of frequencies currently in use in Australasia, VHF, UHF and combined VHF/UHF types, together with versions designed to cover a number of localized situations. See *Fig 3.V.*

Fig 3.V.



The MH-UV1 Amplifier —
This amplifier covers the VHF/UHF T.V. spectrum of 40-860 MHZ, with a gain of 25 dB (VHF) to 30 dB (UHF) and an output capability of 46 dBmV (106 dBμV). This product has a very low noise figure of 2.1 dB (VHF) and 2.7-3.3 dB (UHF).

The MH-UV2 Amplifier —
It is similar in performance, but has separate VHF and UHF input facilities.

Other Mast Head Amplifiers —
Other M.H. series amplifiers cover various groups of frequencies, e.g. the MH-U1 covers UHF (470-860 MHZ), the MH-V1 covers VHF (40-250 MHZ) and the MH—HB covers VHF Band III (174-250 MHZ). These "narrow band" models incorporate two inputs, one for the frequencies to be amplified, the other to pass the remaining channel to the common output without amplification.

All of these amplifiers are Line-Powered, that is the voltage for the amplifier board, which is located at the top of the mast, is supplied via the co-axial down lead.

This low level voltage, is provided in an alternating form, to be rectified and smoothed at the Head amplifier.

Hills find this method is preferable or the use of direct current, as it reduces the incidence of electrolytic corrosion at the amplifier connectors.

3.5.2. Towers and Telo-masts.

Due to the natural curvature of the earth and despite the TV transmitter being sited on top of the highest available local feature, once a distance of some seventy kilometres from the station is reached, even sub-standard pictures cease to be available.

In order that we may retain the Line-of-Sight requirement for good reception, the use of a Mast or Tower, on which to mount the antennae array, now becomes mandatory.

This basic principle, that of maintaining line of sight, is of course just as important in built up city areas, where high buildings often create the same reception conditions as are to be found in the deep finge.

3.5.3. Telo-masts.

For heights up to 15 metres, in non-cyclonic areas and where the head-loading is not excessive, Telo-masts are a convenient, low cost method to mount your TV antenna. A 6 or 9 metre Telo-mast can be readily installed on the peak of most roofs.

This gives the best average height above surrounding obstructions for the inner fringe areas and is equivalent to the use of a ground mounted 15 metre unit.

3.5.4. Masts and Towers.

Where large antenna arrays are required and a Telo-mast is not deemed to be suitable, the use of a Butt Sectioned Mast, or Free Standing Tower, may be required. Masts are available up to 90 metres and Towers up to 30 metres, in most ranges.

3.5.5. Installation of Telo-masts/Masts/Towers.

The installation instructions supplied with masts and towers, should be followed to the letter. Particular attention being paid to the safety aspects of the installation process. Always comply with the safety requirements of the particular local authority.

3.5.6. Fringe Area Antennae.

The general requirement in any "Deep-Fringe" location is to pick-up as much signal as is possible.

This is derived from either direct, or more likely, scattered wavefronts, or a combination of both.

The age old adage still holds true, that "**THE MORE METAL YOU PUT IN THE SKY, TO PICK UP THE REQUIRED SIGNALS AND THE CLOSER THE ANTENNA ARRAY IS TO DIRECT LINE OF SIGHT WITH THE TRANSMITTER MAST, THEN THE GREATER WILL BE THE RECEIVED SIGNAL AND THE BETTER WILL BE THE PICTURE**".

Antenna gain is basically determined by the number of directive elements which are provided to gather in signals from the surrounding atmosphere and deliver them in the correct phase relationship to the driven element and thence to the feeder.

Reflector elements placed behind the driven element reinforce the collecting characteristics of the antenna.

They also help to cancel out the effect of signals arriving from the rear which would be out of phase.

From this it would seem that the bigger the physical size of the antenna, the more signal level it would pick up. This in fact is true, however, if the gain of a given antenna is to be doubled, the number of active elements will need to be increased proportionatly.

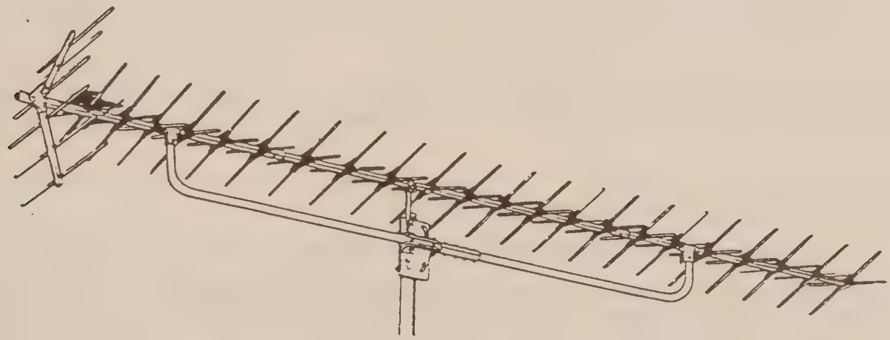
This gives rise to practical, mechanical problems rather than electrical ones, if we strive to achieve the theoretical maximum performance.

Two or more similar antenna may be stacked horizontally or vertically, to provide for an increase in the total gain. Two such antennae would produce a practical increase of some 2.5 dB., the same gain that would be obtained if the signal antenna could be doubled in size.

With the advent of UHF frequencies to Australian television and the much smaller wavelengths which are to be found in Bands 4 and 5, it was found that a technique for producing Yagi antennae, by arranging the equivalent of four separate antennae about a common boom, could provide the EXTRA GAIN required for fringe UHF area.

Even so, such antennae are of a considerable size if gain figures in the order of 18 dB. are to be achieved. See *Fig 3.W.*

Fig 3.W.



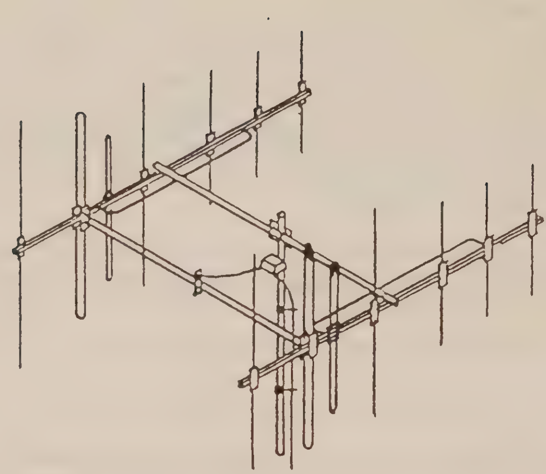
While in most regional areas the National TV service is available, together with at least one Commercial station, at least until total aggregation is achieved throughout Australia, many people will still seek to receive signals from the nearest metropolitan centre.

As these situations are in the main allocated frequencies in Band 3, (174-222 Mhz.), the Hills CA16 antenna is still recommended to receive these distant stations.

Regional transmitters are not always of the same high power as those which are located in our metropolitan areas which means that the "Fringe" begins all the sooner.

In most cases there are currently only two channels and these are located, one in Band 3 and one in Bands 1. or 2. At least until all of Band 2 is cleared for the exclusive use of FM radio channels. *Fig 3.X.* shows a typical array for such a location.

Fig 3.X



In many regional areas the local transmitters, if not already converted to the UHF band, are to be found in the low frequency bands. In either case, these relatively strong local signals can cause overloading to the mast head amplifier, which results in the production of intermodulation products, giving rise to serious degradation of the picture quality.

To prevent this a suitable Band stop filter should be inserted prior to the mast head amplifier, which in turn should posses its own metallic shielding properly earthed.

The local channels will then be prevented from inputting the mast head circuits. Having prevented interference with the reception of the distant channels, a local antenna will be required.

So as not to duplicate the co-axial down lead from these two antennae, use may be made of a suitable diplexer or if this is not available an even or uneven two way splitter. This should be enclosed in a suitable (OH1) outdoor housing. As these products are fitted with power passing features, the choke in the non-amplified leg should be removed and replaced with a capacitor to prevent the possible shorting of the line supply voltage.

Translators and Self-Help television installations in the main utilize low power, (2 Watt), transmitters which are located in the upper part of Band 5. (760-820 Mhz.)

While receiving antennae which are mounted in close proximity to these stations, may be of the basic ten element types, the available signal level soon requires the use of one of the larger types.

3.6. Surveys to Achieve TV Reception.

Reception Surveys are carried out for two basic reasons.

1. To find out if adequate and acceptable signals can be received to make an installation cost effective.
2. In difficult reception areas to determine if a signal can be received in adequate strength and sufficiently free from ghosts and to decide the most suitable type of antenna, its position, height and direction familiar with the antenna types and heights most suitable in his area.

He installs the best type for the area knowing that the reception will be as good as it can be at that site.

Only when new types of antenna become available, or new stations come on line, are surveys required.

In difficult reception areas the situation is not easy to determine. The most useful antenna types for the purpose may be well known, but it is still necessary to survey each individual location.

3.6.1. Fringe Area Surveys.

In distant areas where there is no direct line of sight to the transmitting towers, due to the curvature of the earth, sufficient height is required to be well clear of any buildings or trees which could absorb any of the signal.

A height of 15 to 18 metres above the ground, is, in most case, sufficient until the extreme fringe is reached, so long that the site is located in a basically flat area. i.e. not in a hollow or behind a hill.

For survey purposes this height can be difficult to arrange, so, a 9 metre Telo-mast or something similar may be utilized.

From experience it is possible to estimate the quality of the pictures which will be obtained once the full height has been provided.

If however, the results at 9 metres are such that virtually no signal is available, it is unusual to find that satisfactory results can be achieved at 18 metres.

3.6.1.1. Antenna Types.

For the normal fringe, a high gain antenna such as the TL4, or TC18 will indicate if the signal is available and is likely to produce acceptable pictures.

Where mostly scattered signals are being received the phased array, CA16, or UHF Hunter, will, with few exceptions, provide better results.

In the extreme fringe, Extragain UHF types or arrays of CA16's should be employed.

3.6.1.2. Mast Head Amplifiers.

In fringe areas it is usually advisable to incorporate a mast head amplifier with the antenna before commencing the survey. As, in most cases it would be a waste of time to re-rig with an amplifier after the signals have proved to be too weak.

3.6.1.3. Difficult Area Surveys.

1. Organisation.

Before commencing such a survey it is important to be well organized. A haphazard approach can not only be costly in wasted time, it also creates a poor impression in the mind of the customer. The final result is likely to be less satisfying than could be achieved with an organized approach.

Therefore attention should be given to the following points.

1. The purpose of the survey.

2. The types of problems likely to be involved.

3. The requirements of an installation is such an area.

4. The equipment required for the survey.

5. Methods to use to help solve the problems.

3.6.1.4. The Purpose of the Survey

The purpose of the survey is to find out and to demonstrate to the customer, whether acceptable pictures can be received at the site and if so to determine:—

A. The most suitable antenna type or types.

B. The best position.

C. The best height.

D. The optimum antenna direction.

E. If a mast-head amplifier is required.

3.6.1.5. The Types of Problems which may be Involved.

The problems which are encountered will usually involve one or more of the following:—

A. Reasonable signals but with multiple ghost signals.

B. Weak signal levels with many ghost signals.

C. Selective frequency cancellation.

Problems A. and B. have been dealt with in Section 2.3 but many variations of these problems can be found. Selective frequency cancellation can be caused by reflecting waves combining with each other and with the direct signal.

Out of phase signals, combined with delay times can cause total or partial cancellation and additions of signals at specific frequencies.

This can mean attenuation of the whole channel or of only parts of the channel.

Such attenuations, or troughs, can be expected to be accompanied by adjacent peaks caused by the additions.

The result is an average level across the bandpass of the channel, together with a level well below the average for some portions of the information and a level well above average for other portions of the information.

Depending upon where the peaks and troughs occur on the bandpass of the channel, the effect can be, loss of picture, loss of sound, colour or sync, extra strong sync, distortion of sound or over saturated colour.

Associated effects can be beat patterns, a weak flat picture, an over contrasted picture and AGC problems.

3.6.1.6. Requirements for the Installations.

The requirements for any installation in a difficult area are as follows:—

A. Low loss cable **must** be used.

B. The antenna must be correctly matched on all channels, have good directivity, high front to back ratio and adequate gain.

C. The antenna position will be determined by the survey but the result needs to be practicable from a mechanical point of view.

A — Co-axial Cable.

Because the surrounding atmosphere is full of RF signals, (Two-Way Radio, Motor-car ignition etc.), in direct and reflected waves, the co-axial cable with is utilized, should have a very low through loss, be as well screened as possible and at all times maintain a stable impedance.

(For Television reception purposes 75 ohms.)

Random pick-up of signals by the cable, or standing waves causes by poor impedance matching, result in a severe degradation of the required pictures. It is therefore important to use only good quality cables which must be correctly matched to the antenna and to all coupling or splitting devices which may be employed in the installation.

B — The Antenna.

The antenna is required to meet the requirements for best quality colour reception. This means that the antenna should above all other things be able to match the impedance of the 75 ohm interface cable.

This is required at all of the frequencies that the antenna is required to receive.

It is not difficult to match an antenna at one specific frequency, but to do this over a wide frequency range requires the services of some very skillful engineers.

The antenna should have high gain as this property also gives rise to a better directivity and back to front ratio.

These properties help the antenna to differentiate between the stronger, required signals and the spurious ones, which it is hoped will be eliminated.

C — The Antenna Position.

The antenna height and its position are often found to be critical. A change of 20 cms. in either parameter may make the difference betwenn an acceptable picture and one which is not discernible. Such precise location can create a great deal of difficulty in the practical mounting of the antenna.

A flair for improvisation is a great asset on the part of the installer.

3.6.1.7. Equipment Required for the Survey.

The following equipment should be available for any survey:—

A. A reliable TV receiver. This should be portable but a screen size of 43 cm. is to be preferred.

B. An extension power cord of at least 10 metres, together with a double adaptor.

C. A special Telescopic mast. **

D. A prepared length of low loss co-axial cable, say 25 metres in length.

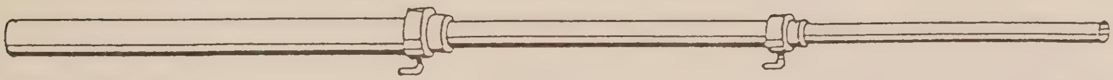
E. A range of suitable antennae.

F. A suitable mast head amplifier.

G. A Two-way radio or other means to enable your survey crew to communicate.

** As considerable variation in height are sometimes needed for the survey, it is convenient to have a readily adjustable mast available. This can easily be prepared from stock equipment as shown. See *Fig 3.Y.*

Fig 3.Y.



Masts required are one 10'6" × 1.75", one 10'0" × 2" and one 10'0" × 2.25". Two locking rings, one for the 2" mast and one for the 2.25" are also required.

The only work required is to drill a clearance hole 1" from the end of the 2" and 2.25" masts for the L bolt to pass through and grip the inside mast.

In use the antenna is mounted on the 10'6" × 1.75" mast initially for tests which are low down, or upon the roof. When more height is required this mast is fitted inside the 10' × 2" mast and the L bolt tightened to hold it where required. The 10' × 2.25" mast can be similarly added for more height again.

At least 30 cm of overlap should be allowed at each joint between masts, which provides a total height of about 8.4 metres will be available.

A length of co-axial cable of about 25 metres should be prepared with a Belling-Lee type plug on each end. Hills DSC32 type co-axial cable can be used but it will have a short working life in this form of usage. Where survey work is a regular procedure, it is preferable to use a cable with a solid polythene dielectric and braided copper outer shield. One suitable cable of this type is RG59/U.

In metropolitan areas the most suitable antenna has been found to be the EFC3 for VHF work, while the TC18 is suitable for most UHF situations. If surveys are performed at regular intervals, it is a good idea to drill out the rivets which hold the elements to the antenna boom and replace them with 3/16" metal thread screws, washers and wing-nuts. This will allow the antenna to be closed easily after use, saving time and many broken finger nails.

In the course of the survey a position may be found where the picture is virtually ghost free but is very snowy.

In this case it is quite likely that this is due to signal cancellation effects. An amplifier is required to see if the extra gain will produce an acceptable picture.

The lead from the survey antenna should be plugged in to the Input of a Wide Band Amplifier, e.g. 2001/1 Amplifier, or one like it and the amplifiers output fed to the survey receiver. Any discernible overload may be corrected by the use of an In-line attenuator or LBA12 low band attenuator.

When frequent surveys are carried out a pair of Two-way radio units can be used to aid understanding and save time. A licence must be held before they can be operated.

3.6.2. Suggested Procedures in Conducting a Survey.

A very important factor in the solving of any problem, is having as full an understanding as is possible, of the problem and the possible causes, Please refer to a previous section related to the subject of ghosting to refresh your memory before proceeding further.

1. Analyse the pictures being received on the cutomers set.

   Connect your own portable set (which you know is 100%) and compare the pictures, just to make sure that the problem is not with the receiver. It has been known to happen!

2. Decide what the problem/problems are by careful viewing. Again check the problem on your test receiver if you are in any doubt.

3. Having decided what you think the problem is, go outside and visually check the current installation. Check the condition of the existing dowlead. Analyse the existing antenna, its position, height and direction. Assess if the antenna is suitable for the situation. **Decide what you think** will improve the present reception.

4. Check nearby installations, if any exist. Note if the antennae are large or small and if any particular type is favoured. Note the general height and on which side of the homes the antenna is located. Note their direction and whether they all point in one basic direction, or varying directions.

5. Analyse with great care all of this information and decide as far as is possible:

   The direction of the MAIN signal.

   The direction of the majority of reflected signals and ghosts. Please note that these can come from several different directions at the same time.

   A position which is protected from the majority of reflections but is substantially clear to receive the main signal. Arrange to place some form of shielding between the antenna and the reflections. The house, it's metal roofing or sisalation, a rainwater tank, garage etc.

   The type of antenna most likely to succeed.

   Some tentative check points to try, bearing in mind that they will need to be practicable.

6. Assemble the selected antenna, which will be either an EFC3 or a TC18, onto the basic mast and to it connect the 25 metre co-axial lead. Insert the other end of the cable into your test receiver. Note that the survey is independent of any existing materials which may be in use.

7. Try out the selected check point, one crew man holding the mast with the antenna in position while the other observes the results on the screen. Rotation of the antenna together with variations in height should be tried, for each shift of position. The picture should be checked on each channel. When rotating the antenna, first move to the left by 90 degrees, then return to Zero and repeat the procedure in a clockwise direction. Where required, if the results are not as good as you expect, add other mast sections and repeat the previous procedure.

8. Note the best signal directions, the areas of strong signal, clean signal and weak but clean signal. Use the amplifier to check if the result improves when amplified.

9. When the whole site has been comprehensively covered, the best compromise position should be selected.

10. Return to the selected position and taking extra care, set up the antenna as before. Move the antenna in all directions, left, right, forwards, backwards, up and down, in small graduations to select the best and therefore final position.

    It is then advisable to connect the survey lead to the customers set so that the quality of the results can be demonstrated in familiar surroundings. If the results are considered to be satisfactory, by all concerned, on all channels, a price should be quoted and a go ahead obtained, in writing.

    NOTE: Make sure that the person who is giving the go ahead has the authority to do so.

Section 4. PRE-PLANNED INSTALLATION LAYOUT

In a previous section we dealt with the principles which are involved in the design of a TV distribution system. To design such a system requires a degree of knowledge which is difficult to acquire, unless you are employed constantly in this discipline.

Accordingly the following section has been devised and is included in this manual to provide a ready reference to the most common installation situations.

It covers most of the situations which are met in day to day quotations. Each layout provides a listing of the recommended material, together with an indication as to the signal level required.

The suggested antenna is based on average situations which are in direct view of the required transmitter station. In other situations a type with more forward gain may be required, or the height of the masting may need to be extended.

4.1. The Layout Groups.

The designs have been separated into three groups. The first uses the prefix H which indicates that the systems are intended for installation in private homes or groups of home units. All would be located within a strong signal area.

The second grouping prefixed AH allows for the provision of amplification where the available signal level is reduced.

The third grouping is intended to be used where installations are proposed for blocks of flats or for multiple level buildings. The required allowances have been made for the differences in cable lengths and cable losses for the different types of buildings, together with an allowance for variations.

The design numbering system is based on the following:—

1. The first figure indicates the number of levels in a particular building.
2. The second indicates the number of TV outlets.

   For example, design 4/20 indicates a four story block with a total requirement for twenty TV outlets (five units per floor).

4.2. Designs for Private Homes and Home Units.

Where low cost systems are required in homes or home units, within a strong signal area, designs shown with the preface H could be suitable. It should be pointed out that these designs use splitters. The isolation Spur/Spur does not provide the level of isolation which is required to meet ASA 1367.

With modern electronic style tuners which are currently employed in receiver designs, this lack of isolation should present no problems.

4.3. Amplified Home and Home Unit Designs.

In many cases there will be enough "Off-Air" signals available to overcome the losses which are provided by any splitter and co-axial cable, in a multiple outlet installation.

The Hills system 2000, Extraset, or Prolink amplifiers have been designed to provide for the extra level of signal which is required to overcome these losses.

In designs prefixed AH such amplifiers have been provided to allow ease of installation by the "Part Time", or Electrician installer, who may from time to time take up this work as an adjunct to this other duties.

4.4. Larger Designs.

Where large blocks of flats are to be catered for it will be common practice for individual floor plans to be repetitive.

In such cases the use of a combination of splitters may be a practical solution when joining the various levels.

This is outlined in the "combination" diagram, which should be studied in conjunction with the Head-End and Splitters diagram.

For systems in buildings of more than four stories, Tee systems, similar to those which have been outlined for blocks of flats, become uneconomic due to the excessive lengths of co-axial cable which would be involved.

Two common types of system are to be found in such buildings.

1. Looped System

A design which makes use of a number of vertical drops of cable, which is interrupted at each floor by a series wired (looped) outlet. Such an outlet plate is graduated in its side loss value, by variations to the involved resistors, to provide for a balance of signals down the building.

Such systems are very cost effective, but are prone to many problems. As the efficiency of the system in total, relies upon the integrity of the individual connections, one destructive tenant, enquiring child, or the like, can ruin the reception of the system for, if not all, a large number of associated units.

2. Trunked "Tee Fed" System

This design is the preferred option so far as Systems Engineers are concerned. However, a prerequisite is the availability of a rising duct in which the vertical cable runs may be located.

A Trunk cable is run via any adjacent corridor ceiling space, to a sequence of multi-port Taps, which are graded to provide system balance. Drop feeder cables then connect the drop taps to individual TV outlets. The individual floor trunks are then linked to the Main Trunk, as oulined in a previous section.

It is not possible to preplan such systems due to the number of variables which can be encountered. Each system will require individual attention.

If after you have read this manual, you still do not feel competent to design such a system, the local branch office of Hills Industries Ltd., Antenna and TV Systems Division would be pleased to receive your call. The full resources of our branch and national planning departments would then be placed at your disposal for a very reasonable charge.

NOTES

SINGLE STOREY HOME UNIT INSTALLATIONS

MATERIAL FOR 2 UNITS

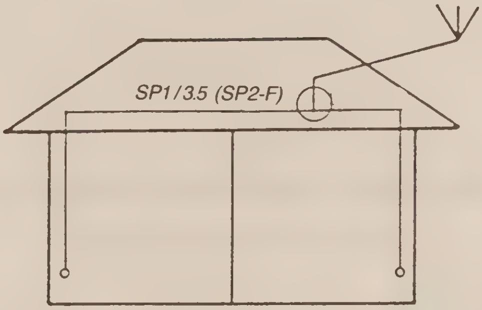
ANTENNA	TL2/PF17
MOUNTINGS	TO SUIT
SPLITTERS	1 × SP1/3.5 (or SP2-F)
OUTLETS	2 × UO1/TV-FM
FLYLEADS	2 × 2M COAXIAL
COAX CABLE	25M X DSC32
INPUT REQUIRED	7dBmV.

MATERIAL FOR 3 UNITS

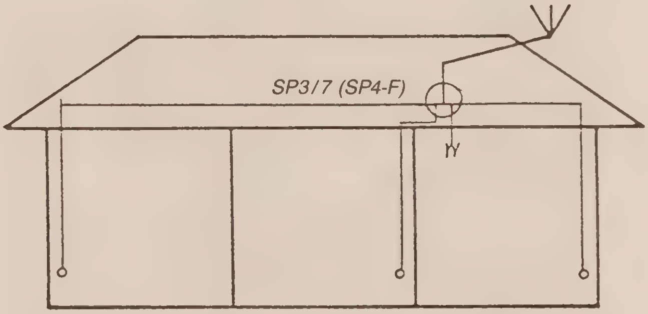
ANTENNA	TL/PF17
MOUNTING	TO SUIT
SPLITTERS	1 × SP3/7 PLUS LOAD (or SP4-F)
OUTLETS	3 × UO1/TV-FM
FLYLEADS	3 × 2M COAXIAL
COAX CABLE	35M × DSC32
INPUT REQUIRED	9dBmV.

MATERIAL FOR 4 UNITS

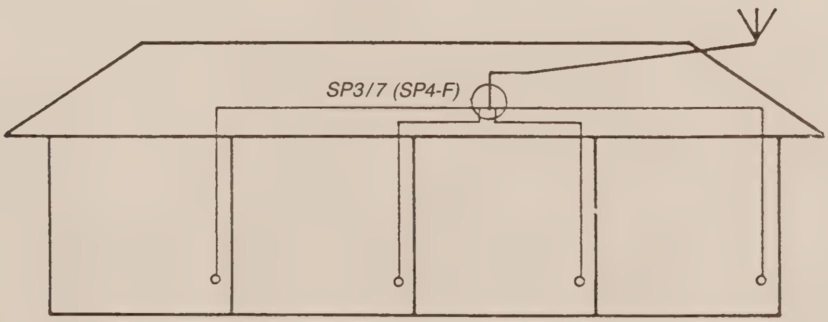
ANTENNA	TL/PF20
MOUNTING	TO SUIT
SPLITTERS	1 × SP3/7 (SP4-F)
OUTLETS	4 × UO1/TV-FM
FLYLEADS	4 × 2M COAXIAL
COAX CABLE	45M × DSC32
INPUT REQUIRED	12dBmV.



H 1/2



H 1/3



H 1/4

TWO STOREY HOME UNIT INSTALLATIONS

MATERIAL FOR 4 UNITS

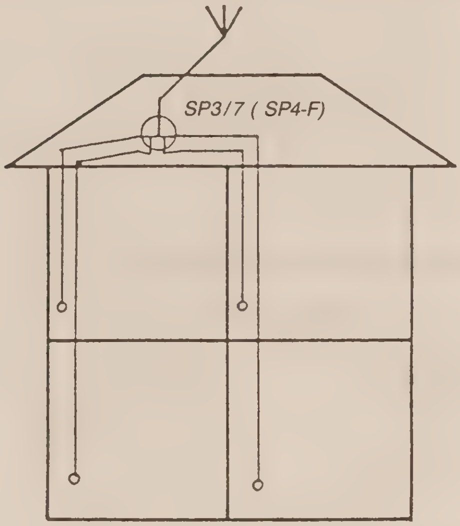
ANTENNA	TL3/PF20
MOUNTING	TO SUIT
SPLITTERS	1 × SP3/7 (or SP4-F)
OUTLETS	4 × UO1/TV-FM
FLYLEADS	4 × 2M COAXIAL
COAX CABLE	50M × DSC32
INPUT REQUIRED	12 dBmV.

MATERIAL FOR 6 UNITS

ANTENNA	TL4/PF28
MOUNTING	TO SUIT
SPLITTERS	2 × SP2/7 & 1 × SP1/3.5 (or 2 X SP4-F & 1 X SP2-F)
OUTLETS	6 × UO1/TV-FM LOADS
FLYLEADS	6 × 2M COAXIAL
COAX CABLE	70M × DSC32
INPUT REQUIRED	16 dBmV.

MATERIAL FOR 8 UNITS

ANTENNA	TL4/PF28
MOUNTING	TO SUIT
SPLITTERS	2 × SP3/7 & 1 × SP1/3.5 (or 2 X SP4-F & 1 X SP2-F)
OUTLETS	8 × UO1/TV-FM
FLYLEADS	8 × 2M COAXIAL
COAX CABLE	100M × DSC32
INPUT REQUIRED	17 dBmV.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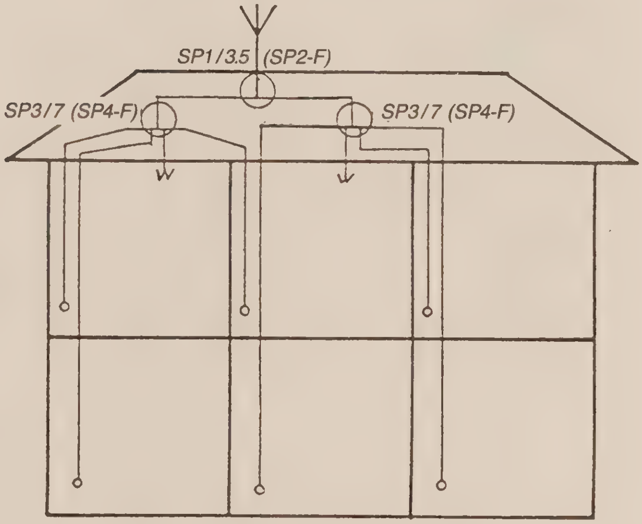
H 2/4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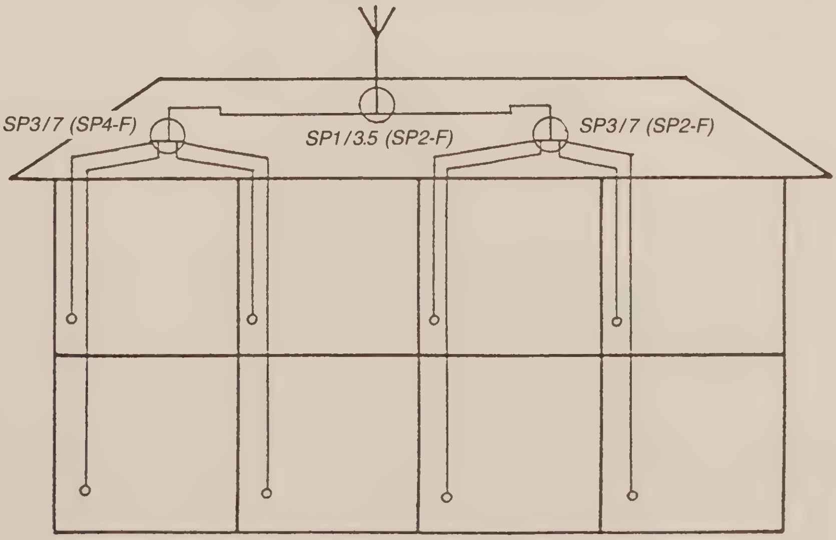
SP3/7 (SP4-F)
SP3/7 (SP4-F)

H 2/6


SP3/7 (SP4-F)
SP1/3.5 (SP2-F)
SP3/7 (SP2-F)

H 2/8

AMPLIFIED HOME INSTALLATIONS

MATERIAL FOR 2 POINTS

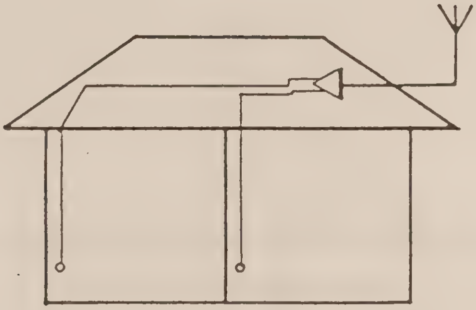
ANTENNA	TL2/PF17
AMPLIFIER	ML20/EXTRASET
OUTLETS	2 × UO1/TV-FM
FLYLEADS	2 × 2M COAXIAL
COAX CABLE	20M × DSC32

MATERIAL FOR 3 POINTS

ANTENNA	TL2/PF17
AMPLIFIER	ML20/EXTRASET
SPLITTER	1 × SP1/3.5 WITH ML20
OUTLETS	3 × UO1/TV-FM
FLYLEADS	3 × 2M COAXIAL
COAX CABLE	30M × DSC32

MATERIAL FOR 4 POINTS

ANTENNA	TL2/PF17
AMPLIFIER	ML20/EXTRASET
SPLITTER	2 × SP1/3.5 WITH ML20
OUTLETS	4 × UO1/TV-FM
FLYLEADS	4 × 2M COAXIAL
COAX CABLE	40M × DSC32



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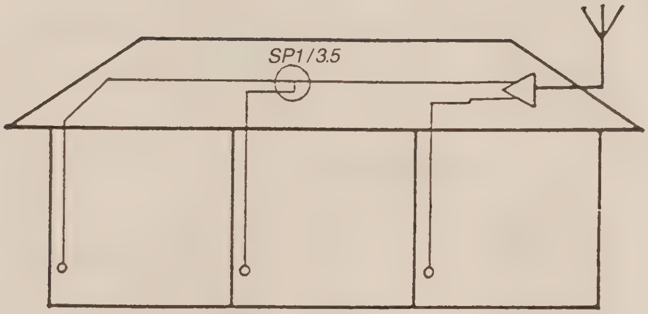

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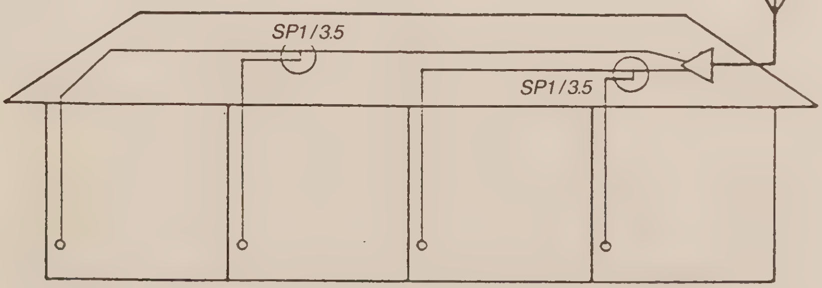


AH 1/4

AMPLIFIED TWO STOREY HOME UNIT INSTALLATIONS

MATERIAL FOR 4 UNITS

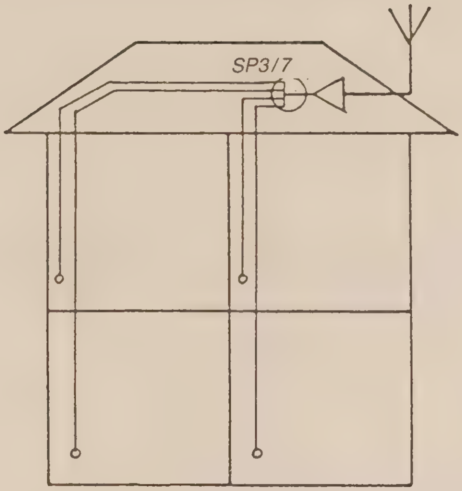
ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
SPLITTERS	1 × SP3/7
OUTLETS	4 × UO1/TV-FM
FLYLEADS	4 × 2M COAXIAL
COAX CABLE	50M × DSC32

MATERIAL FOR 6 UNITS

ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
SPLITTERS	1 × SP3/7 & 2 × SP1/3.5
OUTLETS	6 × UO1/TV-FM
FLYLEADS	6 × 2M COAXIAL
COAX CABLE	76M × DSC32

MATERIAL FOR 8 UNITS

ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
SPLITTERS	1 × SP3/7 & 3 × SP1/3.5
OUTLETS	8 × UIO1/TV-FM
FLYLEADS	8 × 2M COAXIAL
COAX CABLE	105M × DSC32



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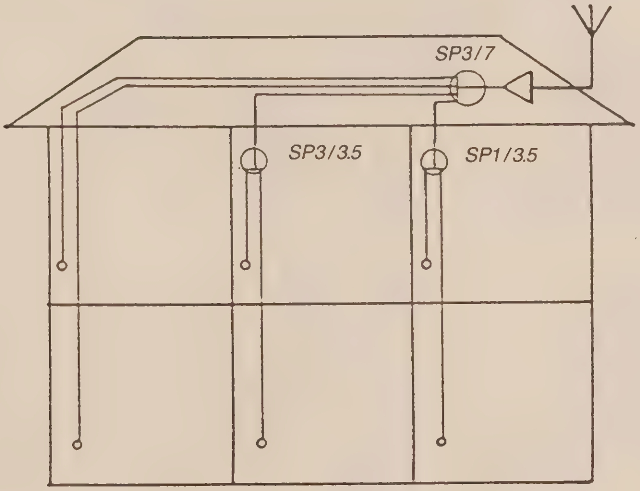

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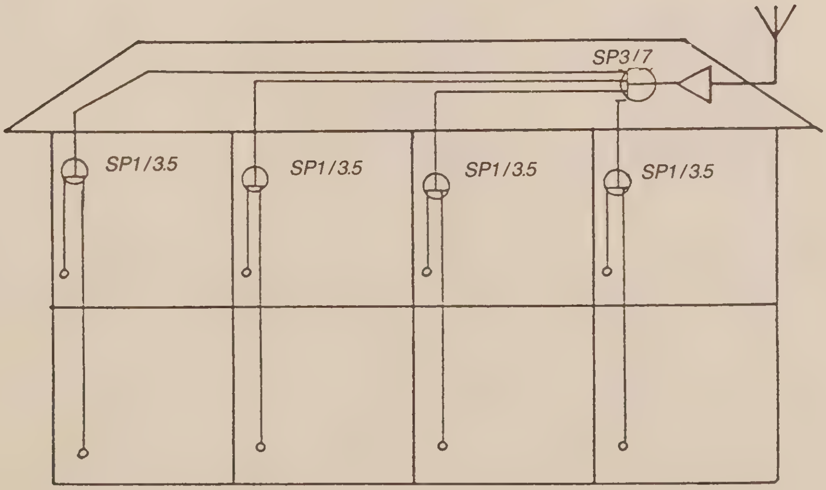


AH 2/8

SINGLE STOREY FLATS INSTALLATIONS

MATERIAL USED FOR 4 FLATS

ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT2/12L & 1 × DT2/12
OUTLETS	4 × UO1/TV-FM
FLYLEADS	4 × 2M COAXIAL
COAX CABLE	61M × DSC32
INPUT REQUIRED	6 dBmV.

MATERIAL USED FOR 5 FLATS

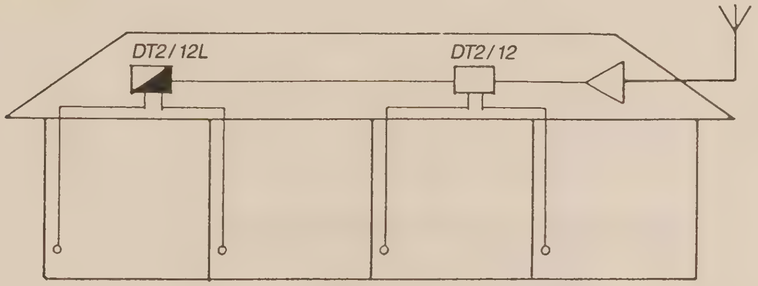
ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L & 1 × DT2/15
OUTLETS	5 × UO1/TV-FM
FLYLEADS	5 × 2M COAXIAL
COAX CABLE	70M × DSC32
INPUT REQUIRED	6 dBmV.

MATERIAL FOR 6 FLATS

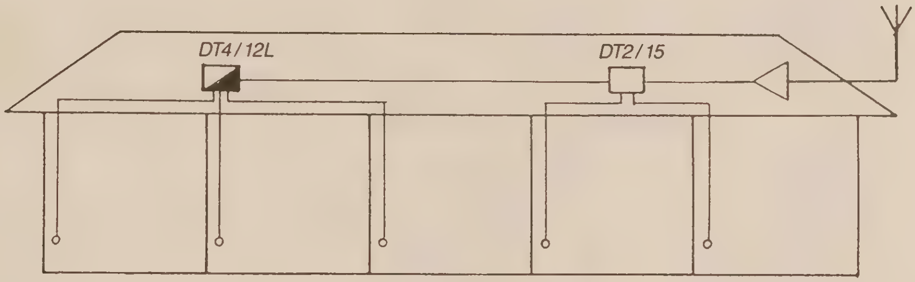
ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L & 1 × DT2/15
OUTLETS	6 × UO1/TV-FM
FLYLEADS	6 × 2M COAXIAL
COAX CABLE	70M × DSC32
INPUT REQUIRED	6 dBmV.

MATERIAL FOR 7 FLATS

ANTENNA	TL2/PF17
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT2/12 & 1 × DT2/15
OUTLETS	7 × UO1/TV-FM
FLYLEADS	7 × 2M COAXIAL
COAX CABLE	105M × DSC32
INPUT REQUIRED	6 dBmV.


DT2/12L
DT2/12

1/4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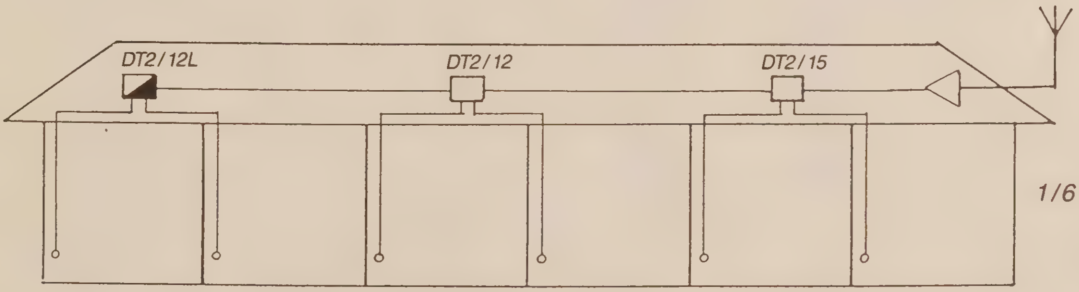
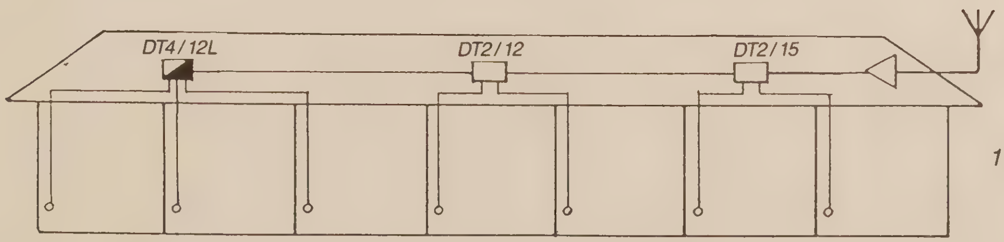
DT2/15

1/5


DT2/12L
DT2/12
DT2/15

1/6


DT4/12L
DT2/12
DT2/15

1/7

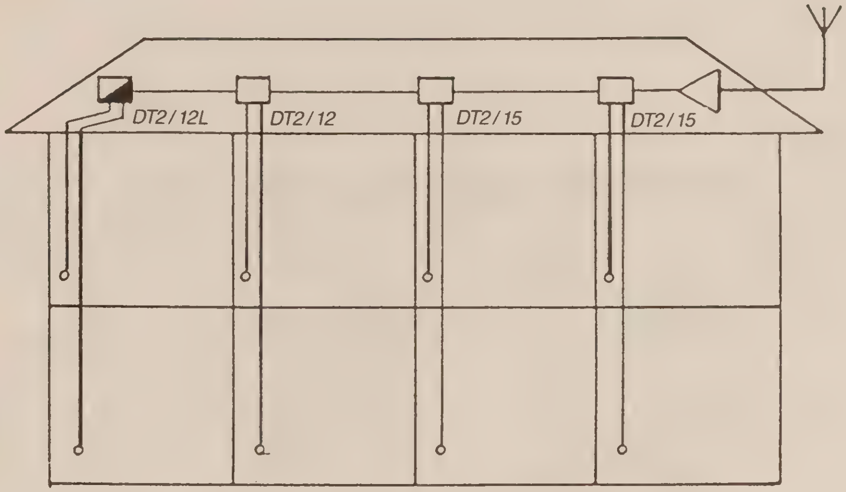
TWO STOREY FLATS INSTALLATIONS

MATERIAL FOR 8 FLATS

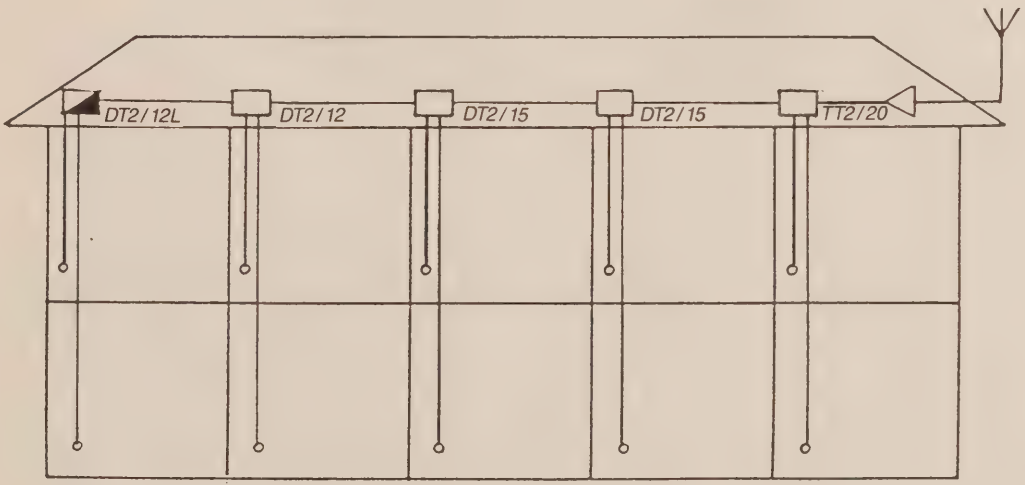
ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT2/12L, 1 × DT2/12 & 2 × DT2/15
OUTLETS	8 × UO1/TV-FM
FLYLEADS	8 × 2M COAXIAL
COAX CABLE	80M × DSC32
INPUT REQUIRED	8 dBmV.

MATERIAL FOR 10 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT2/12L, 1 × DT2/12,2 × DT2/15 & 2 × TT2/20
OUTLETS	10 × UO1/TV-FM
FLYLEADS	10 × 2M COAXIAL
COAX CABLE	130M × DSC32
INPUT REQUIRED	12 dBmV.



2/8



2/10

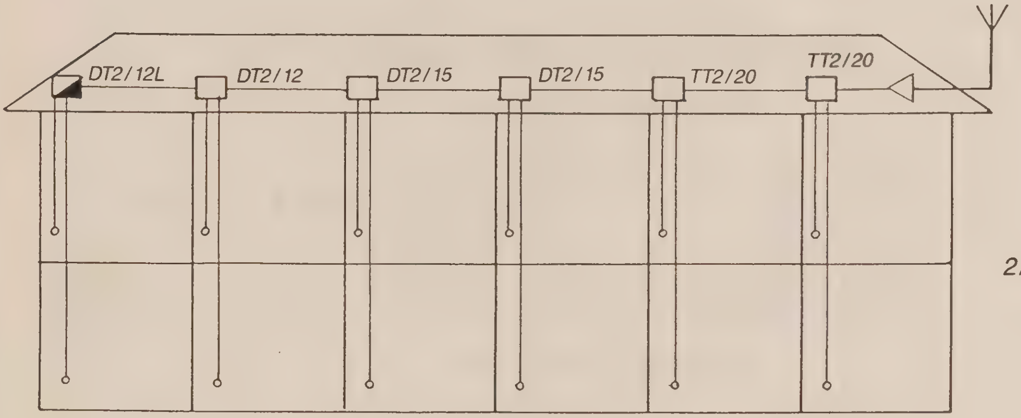
TWO STOREY FLATS INSTALLATIONS - CONT.

MATERIAL FOR 12 FLATS

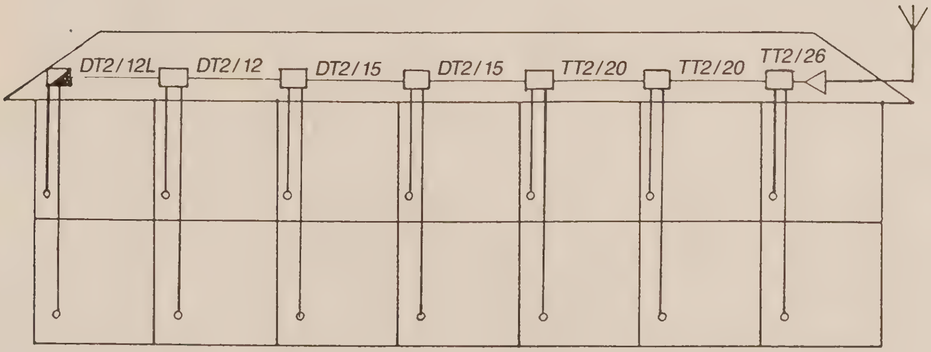
ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT2/12L, 1 × DT2/12, 2 × DT2/15 & 2 × TT2/20
OUTLETS	12 × UO1/TV-FM
FLYLEADS	12 × 2M COAXIAL
COAX CABLE	150M × DSC32
INPUT REQUIRED	12 dBmV.

MATERIAL FOR 14 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT2/12L, 1 × DT2/12, 2 × DT2/15, 2 × TT2/20 & 1 × TT2/26
OUTLETS	14 × UO1/TV-FM
FLYLEADS	14 × 2M COAXIAL
COAX CABLE	180M × DSC32
INPUT REQUIRED	14 dBmV.


DT2/12L
DT2/12
DT2/15
DT2/15
TT2/20
TT2/20

2/12


DT2/12L
DT2/12
DT2/15
DT2/15
TT2/20
TT2/20
TT2/26

2/14

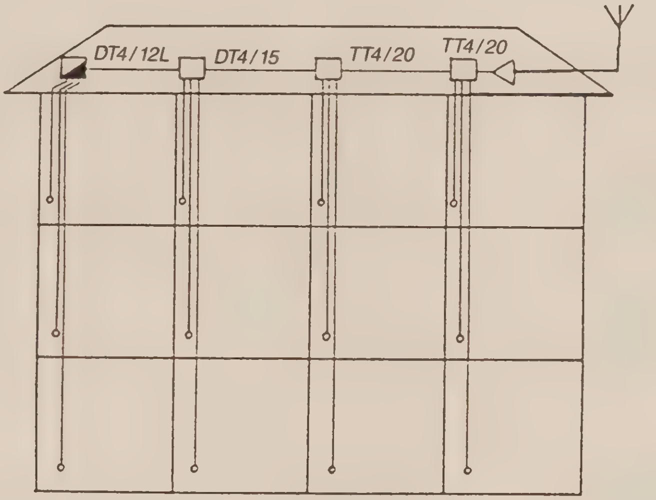
THREE STOREY FLATS INSTALLATIONS

MATERIAL FOR 12 FLATS

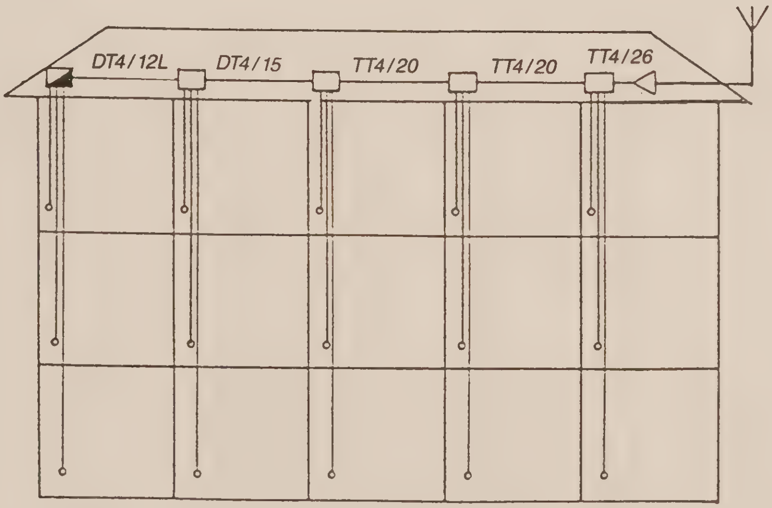
ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15 & 2 × TT4/20
OUTLETS	12 × UO1/TV-FM
FLYLEADS	12 × 2M COAXIAL
COAX CABLE	128M × DSC32
INPUT REQUIRED	11 dBmV.

MATERIAL FOR 15 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15 & 2 × TT4/20 & 1 × TT4/26
OUTLETS	15 × UO1/TV-FM
FLYLEADS	15 × 2M COAXIAL
COAX CABLE	200M × DSC32
INPUT REQUIRED	14 dBmV.



3/12



3/15

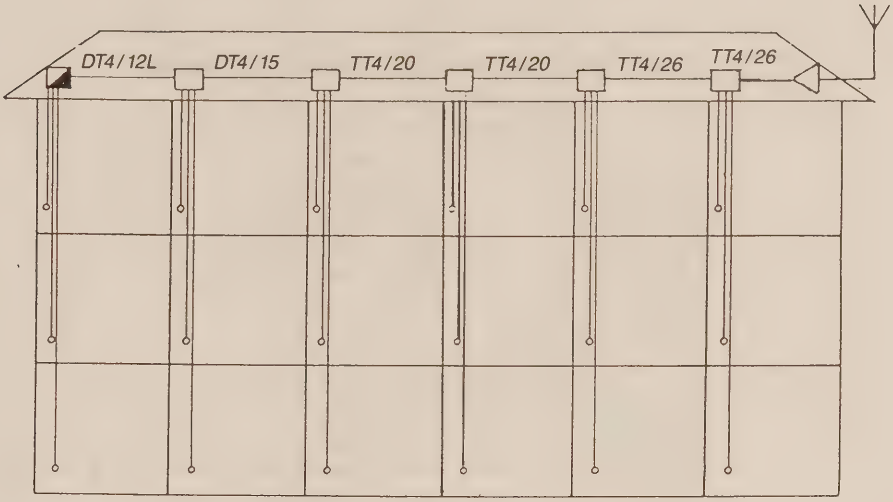
THREE STORY FLATS INSTALLATIONS - CONT.

MATERIAL FOR 18 FLATS

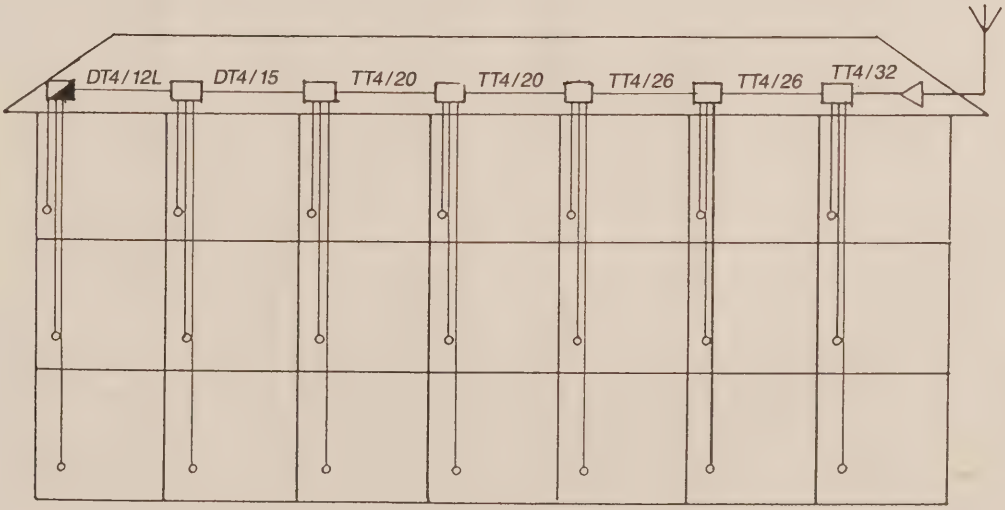
ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15, 2 × TT4/20 & 2 × TT4/26
OUTLETS	18 × UO1/TV-FM
FLYLEADS	18 × 2M COAXIAL
COAX CABLE	180M × DSC32
INPUT REQUIRED	7 dBmV.

MATERIAL FOR 21 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15. 2 × TT4/20, 2 × TT4/26 & 1 × TT4/32
OUTLETS	21 × UO1/TV-FM
FLYLEADS	21 × 2M COAXIAL
COAX CABLE	200M × DSC32
INPUT REQUIRED	8 dBmV.


DT4/12L
DT4/15
TT4/20
TT4/20
TT4/26
TT4/26

3/18


DT4/12L
DT4/15
TT4/20
TT4/20
TT4/26
TT4/26
TT4/32

3/21

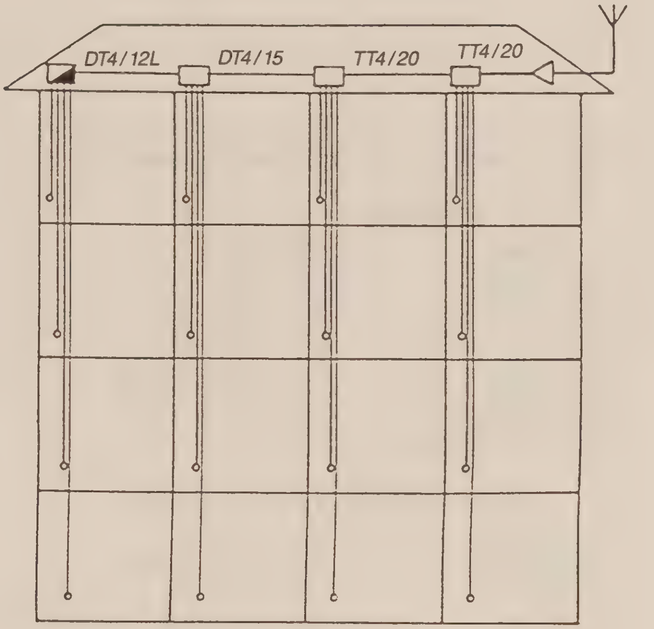
FOUR STORY FLATS INSTALLATIONS

MATERIAL FOR 16 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15 & 2 × TT4/20
OUTLETS	16 × UO1/TV-FM
FLYLEADS	16 × 2M COAXIAL
COAX CABLE	215M × DSC32
INPUT REQUIRED	6 dBmV.

MATERIAL USED FOR 20 FLATS

ANTENNA	TL3/PF20
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 × DT4/12L, 1 × DT4/15, 2 × TT4/20 & 1 × TT4/26
OUTLETS	20 × UO1/TV-FM
FLYLEADS	20 × 2M COAXIAL
COAX CABLE	270M × DSC32
INPUT REQUIRED	7 dBmV.



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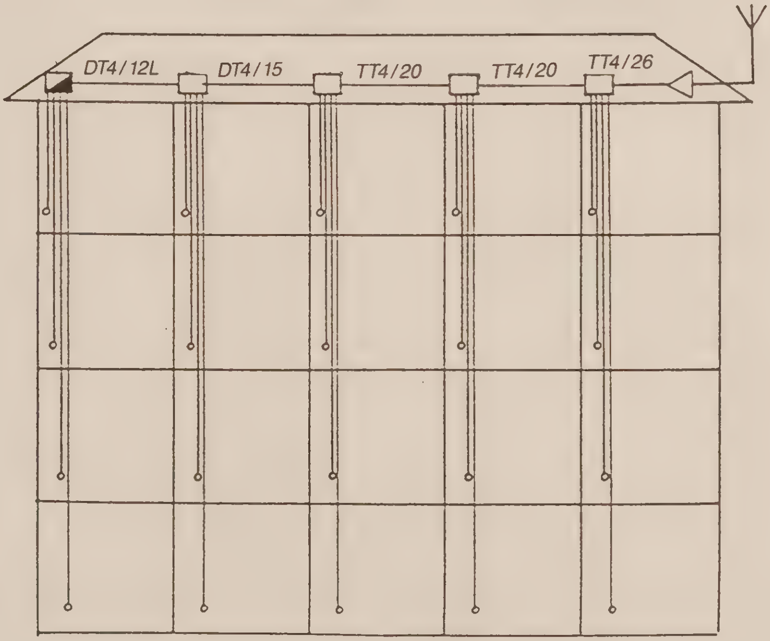

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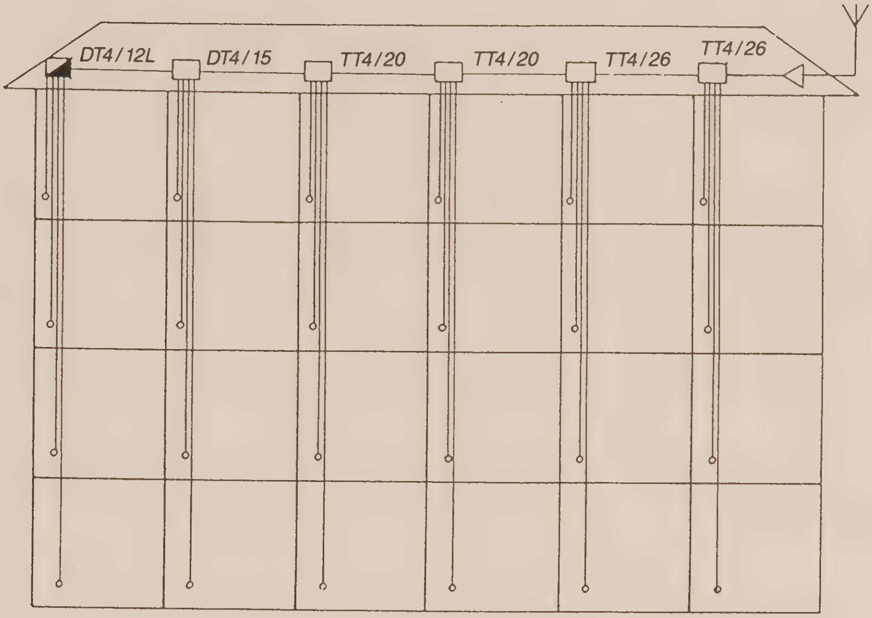
FOUR STORY FLATS INSTALLATIONS - CONT.

MATERIAL FOR 24 FLATS

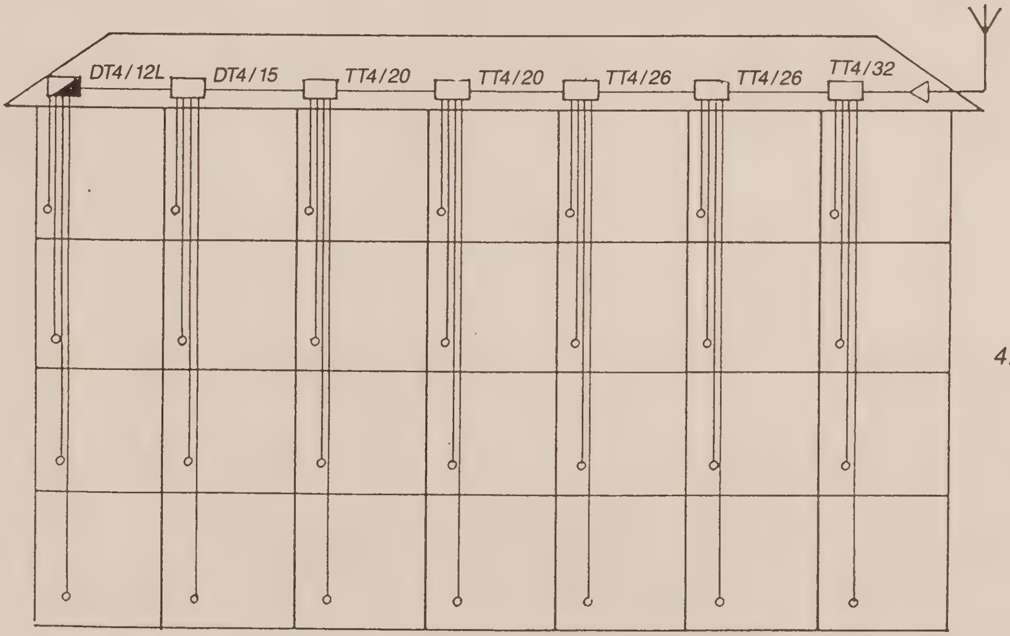
ANTENNA	TL4/PF28
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 x DT4/12L. 1 x DT4/15, 2 x TT4/20 & 2 x TT4/26.
OUTLETS	24 x UO1/TV-FM
FLYLEADS	24 x UO1/TV-FM
COAX CABLE	34OM x DSC32
INPUT REQUIRED	6 dBmV.

MATERIAL USED FOR 28 FLATS

ANTENNA	TL4/PF28
AMPLIFIER	PROLINK/2001-4
TEE UNITS	1 x DT4/12L, 1 x DT4/15. 2 x TT4/20, 2 x TT4/26 & 1 x TT4/32
OUTLETS	28 x UO1/TV-FM
FLYLEADS	28 x 2M COAXIAL
COAX CABLE	385M x DSC32
INPUT REQUIRED	10 dBmV.

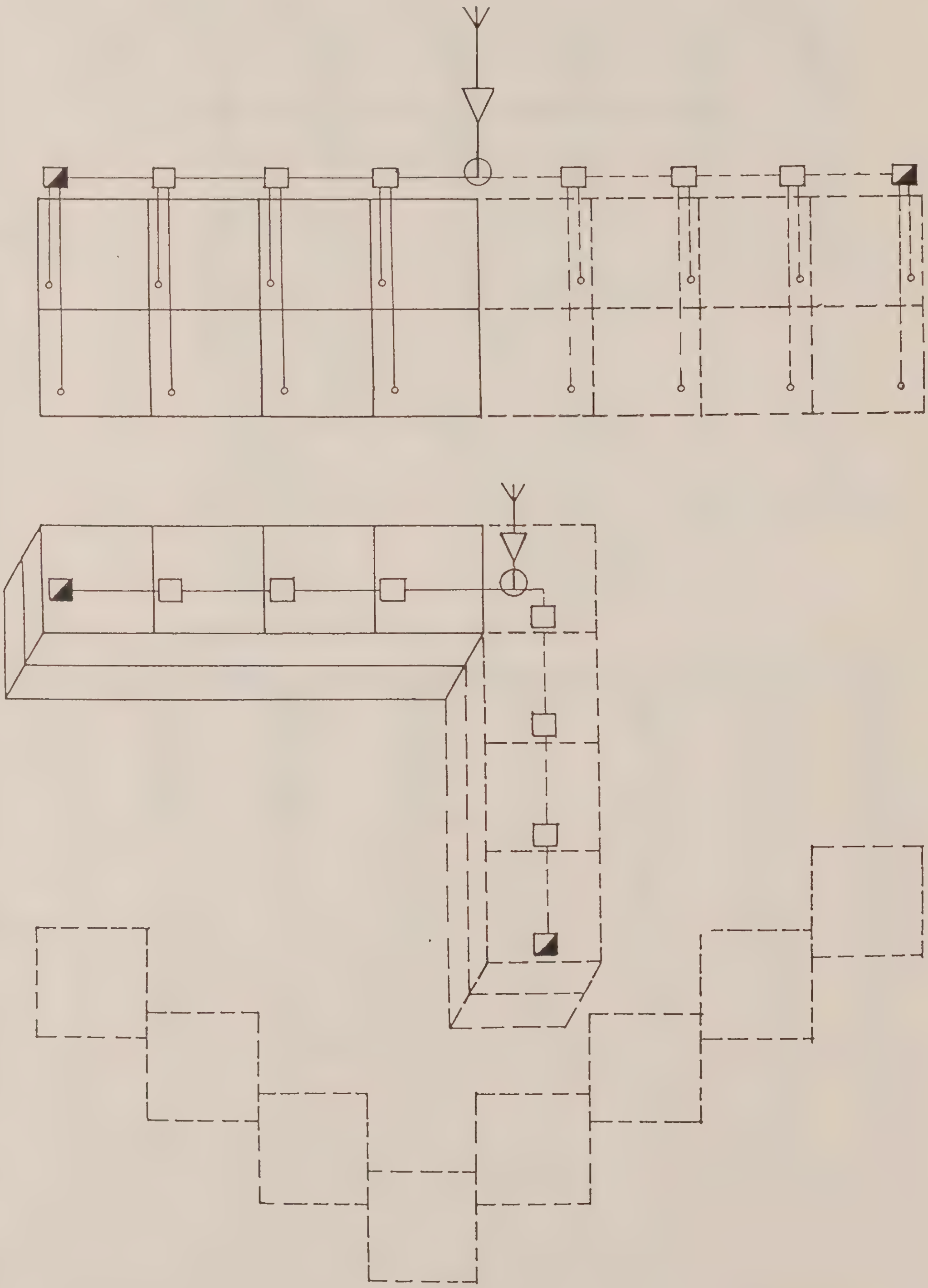

DT4/12L
DT4/15
TT4/20
TT4/20
TT4/26
TT4/26

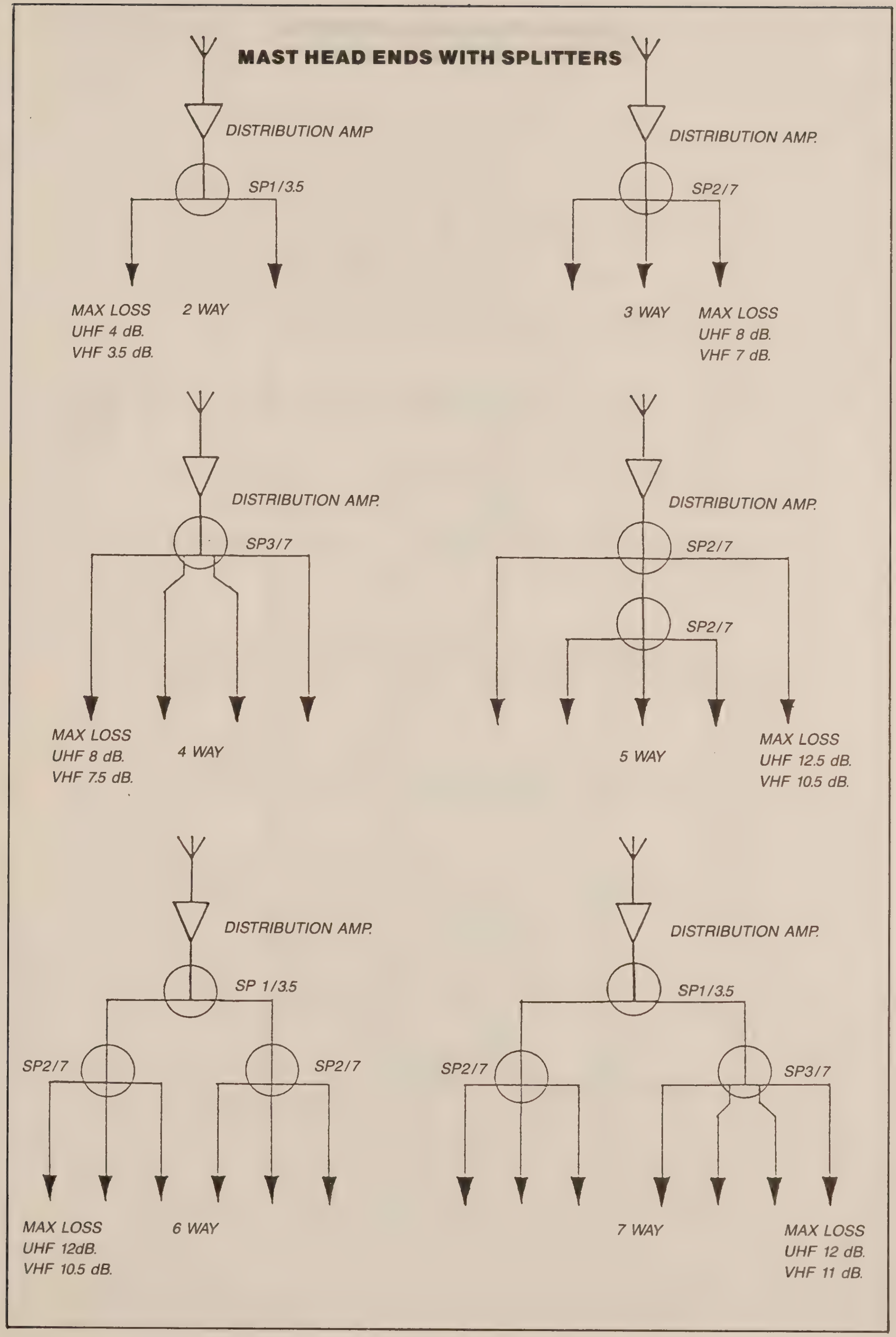
4/24


DT4/12L
DT4/15
TT4/20
TT4/20
TT4/26
TT4/26
TT4/32

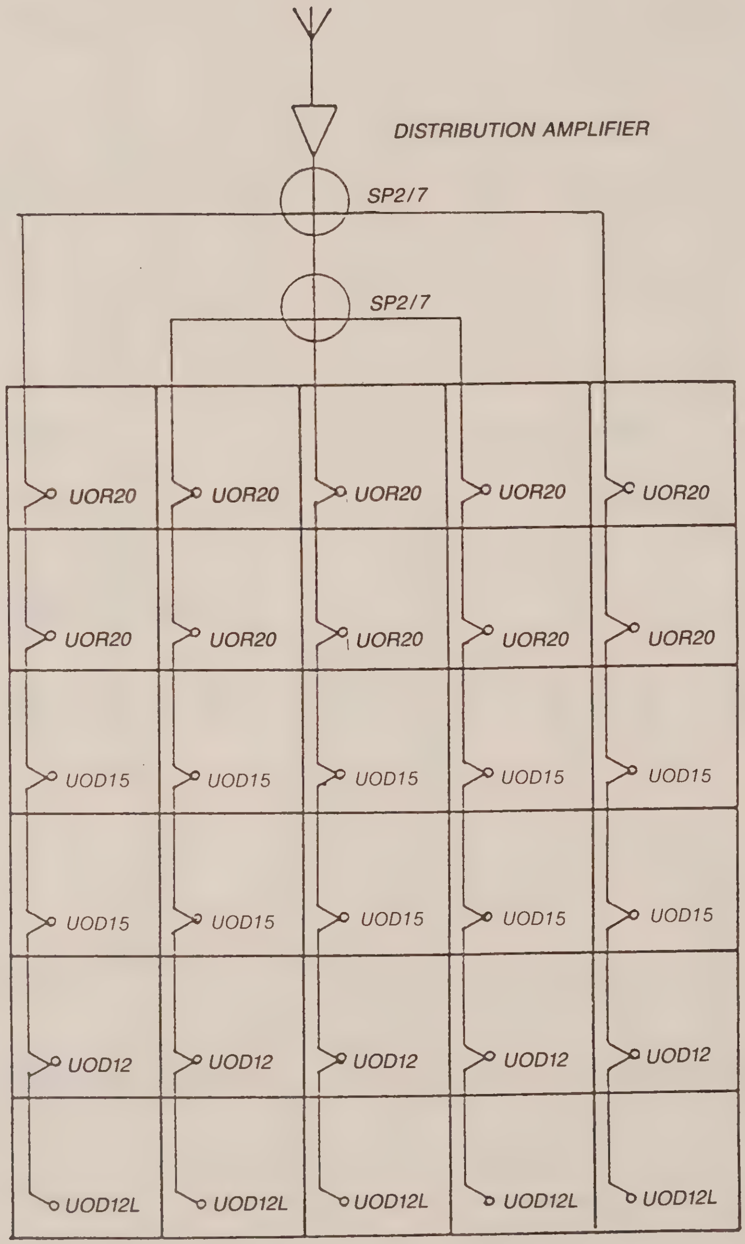
4/28

COMBINATION WITH SPLITTER

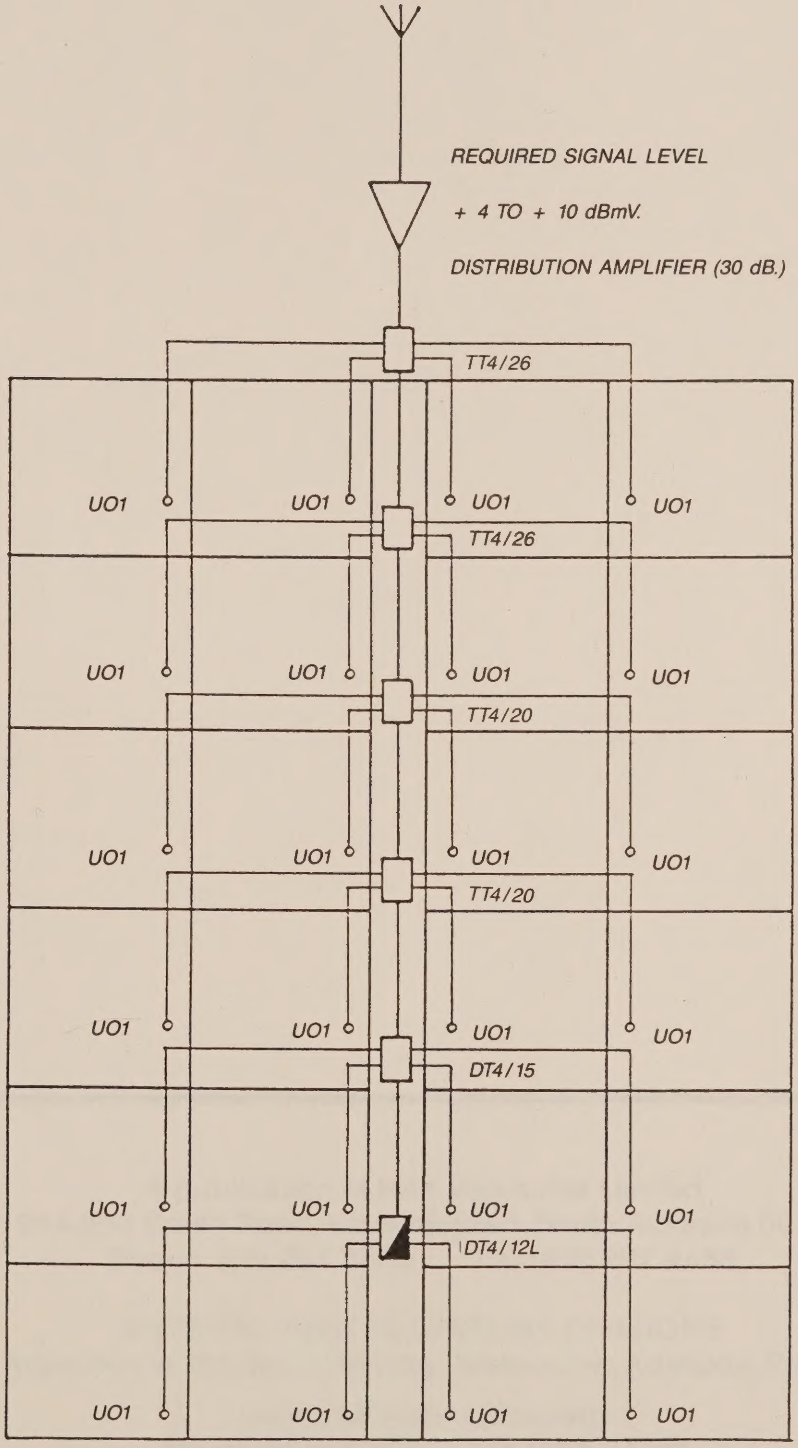



MAST HEAD ENDS WITH SPLITTERS
DISTRIBUTION AMP
SP1/3.5
MAX LOSS
UHF 4 dB.
VHF 3.5 dB.
2 WAY
DISTRIBUTION AMP.
SP2/7
3 WAY
MAX LOSS
UHF 8 dB.
VHF 7 dB.
DISTRIBUTION AMP.
SP3/7
MAX LOSS
UHF 8 dB.
VHF 7.5 dB.
4 WAY
DISTRIBUTION AMP.
SP2/7
SP2/7
5 WAY
MAX LOSS
UHF 12.5 dB.
VHF 10.5 dB.
DISTRIBUTION AMP.
SP 1/3.5
SP2/7
SP2/7
MAX LOSS
UHF 12dB.
VHF 10.5 dB.
6 WAY
DISTRIBUTION AMP.
SP1/3.5
SP2/7
SP3/7
7 WAY
MAX LOSS
UHF 12 dB.
VHF 11 dB.

TYPICAL VERTICAL LOOP SYSTEM
FOR 6 STOREYS - 5 DROPS



MULTI - STORY BLOCK WITH TEE UNITS IN RISER DUCT



NOTES

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